COBOL report program generation by macro processor

Thesis

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COBOL REPORT PROGRAM GENERATION BY MACRO PROCESSOR

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ABSTRACT

The research described is directed towards the development of an interactive COBOL program generator. This aims to simplify computer usage and contribute to the more effective use of computer resources, by alleviating the burdensome, time-consuming and error-prone activity of programming.

The work is based on PG/1, an existing macro processor, and in particular considers the generation of report programs.

The problems of program generation by macro processor are first explored using Filetab, an existing report specification language, and avoiding the interactive aspect. This establishes the feasibility of generating COBOL programs but identifies shortcomings in the macro processor facilities. Enhancements to the macro processor are defined and the PG/2 version is created for use.

The development of an interactive self-instructional COBOL report program generator for the casual user is chosen as the area for deeper investigation.

From a consideration of data bases and query languages it is concluded that a relational view of the data forms the most natural basis for a computer-dominated, non-procedural report-specifying dialogue with a casual user.

A design study for an interactive self-teaching COBOL report program generator, based on the PG/2 macro processor and offering some of the benefits of a Relational Data base Management System, is described. The validation of the user's responses is a major undertaking and leads to a large system. Details of the macros implementing selected features are presented.

It is concluded that program generation appears efficient but may be of even greater use to a professional programmer than to the non-specialist user. The PG/2 macro processor, although not an ideal tool for COBOL program generation, serves to identify the characteristics of an appropriate tool. There is potential for extending and adapting the techniques used to other applications.

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SEPARATE FOLDER OF LISTINGS

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE PROJECT

With the increasing number of computers in use, especially smaller ones, there is a growing demand for computer programs. This demand will soon greatly exceed the number of programmers available to undertake program development. In general computers are difficult to use especially by the non-programmer, but increasingly such people will be required to make use of a computer. There are three approaches by which a non-programmer can make use of a computer:

1. He can learn to program.

2. He can brief a programmer to develop a program to meet his requirements.

3. The computer scientist can create a system which enables the non-programmer to communicate his requirements directly to the computer.

The first approach is time consuming. The second approach may be expensive (even if a programmer is available) and there is potentially a poor interface. Between the realisation of the problem and obtaining results, both these approaches suffer delays while the program is coded and developed. Coding is often a burden, especially in a verbose language like COBOL.

The third approach is also potentially expensive and carries with it the problem of defining the 'user interface'. It does, however, have the important advantage of shortening the time between the realisation of a problem and obtaining results. It is in this latter approach that a program generator and a problem orientated language play a significant part.

A program generator is a computer software package which

will produce a program to perform a specific version of some general application, when supplied with data specifying the requirements for the particular application. The purposes of a program generator are twofold:

1. To make it 'easier' to use the computer as a tool for problem solving by providing a means of creating an appropriate user interface.

2. To enable the user to use the computer 'more efficiently'.

By making the use of a computer a more natural process, the program generator serves to shorten the time between the realisation of the need for a computer program to solve a problem and the completion of a working program. This approach should use less resources when the creation of a program is followed by its regular use. Not only does the use of a program generator assist the professional programmer to develop a program more efficiently, but it is also a step towards the goal of allowing a much larger class of users to use the computer as a problem solving tool.

Non-procedurality is essential in the design of problem orientated languages for use with program generators. That is to say, the trend must be towards systems where the user specifies the problem to be solved and not 'how' the problem should be solved. For example in a statistical package, such as EASYSTAT [24], the user describes in short English phrases the computation he wishes carried out on the data, e.g. Multiple linear regression using 20 variables. He does not have to define the formulae and processing needed to obtain the answers. Similarly with a report generator system, e.g. Filetab [7], the user has only to supply directives describing the files containing the data and the form and content of the required report. He does not have to specify how the files are to be processed to extract the data, nor how it

is to be reorganised into the form required in the report.

There are two possible approaches to non-procedural languages:

1. The creation of an interpreter to translate the statements of the high level language into machine code instructions which are immediately executed, c.f. Filetab.

2. The creation of a compiler which makes use of the overall statement of the problem and produces a machine language routine to be executed later, c.f. this project.

When dealing with a very high level language (and a non-procedural one at that) there is a need to evolve the language in the light of experience. Also the non-procedural very high level language needs to be compiled into a procedural high level language such as FORTRAN, COBOL etc.

In the creation of any problem-to-problem translator the facility to manipulate strings of characters is essential: macro processors have been shown by McIlroy [1], Halpern [2], Strachey [3] and Brown [4] to meet this requirement. A macro processor provides general purpose string manipulation facilities for language translation. It has the added advantage that extensions to the language, created to meet the user's changing needs, can be achieved by macro extension.

It has already been shown by Mandil [5] that a general purpose macro processor can be used as a powerful tool in the development of a general purpose translator. As an alternative to a special purpose interpreter, this study investigated 'problem-to-FORTRAN' generation in order to create an efficient system for solving a range of numerical problems. Under this system the problems are specified at a terminal by means of a user/system interactive dialogue. The system assumes the initiative for most

of the time and interrogates the user about his problem. The user is guided at every step and default options are provided to cover common requirements. The system relies on the existence of a good library of numerical subprograms.

In the scientific field problems tend to be characterized by a low volume of input data, complex algorithms, a considerable amount of mathematical calculation and relatively simple output formats. By contrast in the commercial field emphasis changes to a high volume of input data, straight-forward algorithms, a lower level of computation and the production of printed reports and/or output files, which may have quite complex formats.

This project was initially motivated by an investigation of ways to make it 'easier' for the casual user to use the computer as a tool for solving a limited range of commercial data processing problems. Essentially the interest lies in whether ways can be found to help the user use the computer more efficiently - that is to investigate ways of reducing wastage in terms of time and resources at the man/computer interface.

The problems of communication between user, systems analyst, programmer and computer are chiefly responsible for the inefficient use of resources. The aim is to remove some of these difficulties by the creation of a system where the non-programmer can communicate a range of simple problems directly to the computer, in order to produce a program to solve his problem. Thus shortening the time span between the realisation of a problem and obtaining results.

One of the commonest problems in the commercial environment is the 'request for a report', which usually means the regular repetition of relatively long runs of relatively straight-forward data processing. Another consideration is the production of

report programs for small (micro) computers. A program generator running on a large machine may be a good way to tackle this problem. It is the solution of problems like these that the COBOL generation work described in this thesis represents an exploratory step. Report program generation is a good test case because it covers a variety of important techniques. If difficulties arising in the generation of COBOL report programs from information supplied by a casual user can be overcome, then it is likely that a wider range of problems can be solved by the generation of a COBOL program.

1.2 AIMS

The object of this work on COBOL program generation has been to discover and explore some of the benefits that could arise from carefully and systematically exploiting a relatively small number of basic ideas. The key idea is that of using a computer dominated dialogue as a basis for generating a syntactically and semantically correct COBOL report program. The success of generating a syntactically correct program is readily measured, but that of generating a semantically correct program is less quantifiable.

The main aims of the work are as follows:

1. To explore the problems of COBOL generation.

2. To explore the software for dialogue based program generation.

3. To develop a computer/user dialogue, in a relatively non-procedural language, by which the casual user can describe the report he requires.

4. To develop a system, which makes use of the information gathered during the dialogue, to generate a syntactically correct program.

5. To generate COBOL programs that have an efficiency

comparable with that of hand coded programs, but which require fewer man hours and computer resources for their development.

6. As a step towards ensuring the generation of semantically correct programs, to provide some features which help check that the user's requests are sensible and allow him some opportunity to verify that the program output will meet his requirements.

7. Ultimately, to consider some other aspects of programming and COBOL program generation.

1.3 APPROACH

Although the 'request for a report' was selected as the area for deeper investigation, throughout the design stages of the project the possibility of extending the range of problems, which could be solved by the generation of a COBOL program, was born in mind.

The practical work for this project was undertaken using an ICL 1900 series computer and this greatly influenced the choice of software. The PG/1 macro processor [5] was selected for the development of the COBOL program generator for two main reasons:

1. It represented the only convenient general purpose string processing system available on the ICL 1900 series computer at the start of the project.

2. The macro processor had previously been used for a FORTRAN generation project, against which it was interesting to compare the problems encountered in the generation of COBOL.

The PG/1 macro processor was a successor to the MP/1 macro processor [6].

The project began by investigating the feasibility of, and problems encountered in generating effective COBOL programs from a normal report generator language using the PG/1 macro processor.

It was decided to use an existing report generator language as the problem specifying language, because this had the advantage that comparisons in the size and efficiency of the generated COBOL program could be made. It also permitted all the effort to be directed towards the development of the macro definitions without the burden of designing a problem specifying language. The National Computing Centre's Filetab package [7], whose ICL 1900 series version is called TABN, was an appropriate report generator language for this purpose. The Filetab language features are very comprehensive, so for the purposes of this initial study a subset was selected. These covered the simpler facilities required for generating a typical report.

The initial study showed that acceptable COBOL programs could be generated by using macro definitions to translate the report specifications. This stage of the project served to identify enhancements to the PG/1 macro processor in order to give greater manipulative power and flexibility. The necessary enhancements were defined and this led to the creation of the PG/2 macro processor, which formed the basis for the remainder of the project. (The implementation of these enhancements did not form part of the candidate's work on the project.)

A design study was then undertaken to develop a non-procedural computer/user dialogue as a means of specifying the form and content of the report. As part of this study consideration was given to current work on data bases and query languages. The aim of the project was to express the dialogue in terms of the user's view of the data. In addition to requesting answers to specific questions, the computer dialogue adopts a tutorial approach by displaying instructional text illustrated by examples. From this study it became apparent that it was possible

to develop a system incorporating some of the benefits associated with Data base Management Systems (DBMS). In particular it became clear that the user need not be aware of the actual data formats and that each user could be given his own view of the data. Although any form of data description could have been adopted, a relational language was chosen because it seems to be the more natural from the casual user's point of view. Besides providing an element of data independence it emerged that there was scope for the creation of a range of 'privacy' mechanisms.

The outline design for a complete relational 'DBMS' type system for the generation of COBOL programs to print a report for the non-programmer was prepared. The system consists of three main parts.

The first part, for use by a 'Data base Administrator', consists of macro definitions to create and maintain a Catalogue of File descriptions which describe the data in the data base. Essentially the person in charge of the system has to maintain a data dictionary which includes specifying how each class of user 'views' the files available. The files described in the Catalogue may be on various media, organised in a variety of ways and need not have been designed primarily for use in a relational data base. The system provides for the creation of a privacy mechanism to protect the data when it is accessed by the generated COBOL program.

The second part of the system is self-tutorial in approach and gathers, by means of a computer/user dialogue, information about the report required by the non-programmer user. This information is stored in ways which enables the third part of the system to generate the COBOL program to produce the report the user requires. As well as being self-tutorial, the second part of

the system is designed to incorporate a 'help' facility to enable the user to change his mind about an earlier decision and to experiment with report layout designs. The system also permits the user to view a sample of computer/user dialogue which covers a situation similar to that at the point where he requested help. Throughout the dialogue there are many instances where the user may opt for the default reply to a question and thus reduce the amount of information to be keyed in.

The maintenance of the data base Catalogue and the computer/user dialogue are designed as foreground jobs to be run at a terminal. The generation of the COBOL report program, its compilation and execution and the maintenance of the data base files are designed to run in background mode under a batch operating system.

The technical effort required to implement a fully operational system would greatly exceed the time and facilities available for practical work with this sort of project. The practical work for this stage of the project was therefore directed towards the implementation of selected key features and served three main purposes:

1. To validate aspects of the candidate's ideas and system design.

2. To explore the problems with dialogue creation and program generation using the macro processor.

3. To establish the validity of the generated COBOL programs.

1.4 RESULTS AND CONCLUSIONS

Although a fully operational system is needed to validate the potential of the approach adopted, the project shows that a dialogue can be created which can be used to generate COBOL programs. The validation of the user's responses is a major undertaking leading to a large system. Program generation appears efficient but may be of even more use to the professional programmer than to the casual user. The macro processor, although not an ideal tool for the generation of COBOL programs, served to discover the characteristics of an appropriate tool. The project can easily and naturally be extended in many ways.

1.5 OUTLINE OF THESIS

The PG/1 macro processor and the Filetab system are briefly described in Chapter 2 and Chapter 3 describes the development of the Filetab to COBOL program generator. The extension of macro processor facilities for implementation in the PG/2 version are described in Chapter 4.

In Chapter 5 the user interface and the development of a computer dominated dialogue with the user is discussed. Chapter 6 contains the specification for the Data base type self-tutorial system for the COBOL report program generator. The implementation of selected features of the system is described in Chapter 7. Finally, in Chapter 8 an appraisal of what has been achieved is made and pointers to areas which merit further study are identified.

The chapters are supported by material in a number of Appendices to which appropriate reference is made in the text. A separate folder of listing is also provided.

CHAPTER 2

BACKGROUND TO THE PRELIMINARY STUDY

2.1 INTRODUCTION

The purpose of the preliminary study was to establish the feasibility of generating effective COBOL report programs from a specification in an existing report generation language using a macro processor. The preliminary study was based on two existing pieces of software:

1. PG/1 Macro Processor [5].
2. NCC Filetab Package [7].

A subset of the Filetab language features was selected for use in specifying a request for a report. This enabled all the effort to be directed towards the development of macro definitions for generating the COBOL report program.

The following sections of this Chapter, supplemented by Appendices I and II, aim to provide background information about the software used during the preliminary study. Annotated examples of their use are also included.

2.2 PG/1 MACRO PROCESSOR

2.2.1 What is a Macro Processor?

A macro processor is described by Mandil [5] as 'a string transformation system which evaluates a source string, or macro call, to produce an object string'. The object string format is determined from text previously input as a macro definition, which consists of a macro name and a macro body containing the expansion string (Appendix I Section 3). Both the macro name and the macro body may contain one or more references to dummy parameters. A macro call consists of a previously defined macro name which may incorporate one or more actual parameters. When a macro call is

evaluated it is replaced by the expansion string with any actual call parameters replacing dummy parameters in the macro body (Appendix I Section 4).

2.2.2 Macro Processor features

The general features of a macro processor may be considered under five main headings:

1. Environment
2. Syntax
3. Evaluation of Macro calls
4. Macro-time facilities
5. Implementation methods

The environment in which a macro processor is embedded is determined by the language into which the macro processor maps i.e. its base language. A special-purpose macro processor is one that is applicable only to a single base language whereas a general-purpose macro processor is one that is applicable to a wide range of base languages.

The syntax of the macro processor governs the form of macro name, formal parameters, replacement body and macro calls. The syntax of the latter is of most importance because it influences the convenience of use and the range of applications of the macro processor.

There are two ways in which macro calls, and in particular nested macro calls, can be evaluated. In 'call by value', the nested call is evaluated immediately it is encountered and replaced by its value. In 'call by name', the outer call is fully expanded first.

The macro-time facilities constitute the programming language of the macro processor. They are mainly instructions that define and manipulate the macro-time entities and occur as

statements within the macro body.

Three considerations are fundamental to the implementation methods of a macro processor:

1. The number of times the source text is scanned.
2. The way in which macro-time statements are handled.
3. The storage of text by means of a stack or the use of a list structure.

2.2.3 Principal features of PG/1

The PG/1 general-purpose macro processor is a successor to the MP/1 macro processor [6], which has the following properties:

1. Macro call are acceptable in certain contexts only and macro name recognition is then carried out character by character.
2. Nested macro calls are evaluated immediately they are encountered.
3. Nested macro definitions and definitions within macro calls are not permitted.
4. Macro-time statements are pre-compiled.
5. Text storage is in a stack-based structure.
6. One pass is made over the source text.
7. Special warning markers are employed.

The MP/1 macro processor was biased towards FORTRAN, but the enhancements provided in the PG/1 version by means of macro-time facilities tended to remove the bias and make PG/1 suitable for the generation of COBOL. The new macro-time facilities provided by the PG/1 macro processor include:

1. The ability to write messages to the user, read messages input by the user, construct output messages and analyse input messages.

2. Symbol and character manipulation. This involves the creation of a few macro-time stacks and associated macro-time statements.

3. The creation of facilities which allow the repetitive use of a group of macro-time statements with a provision for them to be dynamically parametized.

2.2.4 Minor modifications to the PG/1 macro processor

At the outset of this project it became apparent that three minor modifications to the existing PG/1 processor would be advantageous for the purposes of generating COBOL statements from Filetab directives.

1. Additional long string variables would be required so the number available was increased from three to ten.

2. The maximum length of a string variable should be increased from 60 to 72 characters so that it could store all the characters in either the input or output buffer.

3. The FORTRAN convention of character six in a statement as a continuation marker for macro-time statements requiring more than one line was suspended, because it interferred with the generation of statements containing characters in the sixth position.

The above modifications were therefore incorporated in the version of the PG/1 macro processor used for the preliminary investigation, whose facilities are described in Appendix I and illustrated in the following subsection.

2.2.5 Examples showing the use of the PG/1 Macro Processor

Example 1.

This example shows the statements for filing the definition of macro FILECHECK in the TESTRUN subfile and then executing the FILECHECK macro. The macro itself requests input from the user and generates two output records which are appended to the COBOLPROG subfile.

%MACRO %BEGIN	Initialise the PG/1 system (Appendix 1 Section 6.1 and 6.2)
%FILE,0,TESTRUN$	Cause all subsequent statements up to but excluding the one containing the 8 % characters to be stored at the beginning of the TESTRUN subfile. (Appendix I Section 6.5)
%DEF FILECHECK	Define the macro named FILECHECK. The following statements up to %END form the macro body. (Appendix I Section 3)
%1 READ	Read a record into the PG/1 input buffer. (Appendix I Section 7.17)
% CALLFSTR(#LV1,1,5)	Extract the first five characters of the input buffer into local variable #LV1. (Appendix I Section 7.4)
% IF #LV1.EQ.'*FILE',GOTO 2	Test if the contents of #LV1 is equal to *FILE and if so pass control to the statement labelled 2. (Appendix I Section 5)
% CALLCOPY(1,INVALID%*FILE%RECORD)	Set up error message in the first 20 characters of the PG/1 output buffer. (Appendix I Section 7.3)
% WRITE	Write out the error message from the output buffer. (Appendix I Section 7.24)

`%  GOTO 1`	Pass control back to the statement with label 1. (Appendix I Section 7.11)
`%2  CALLFSTR(#LV2,6,8)`	Extract 8 characters from the input buffer into local variable #LV2 starting at position 6 of the buffer. (Appendix I Section 7.4)
`%  CALLFSTR(#LV3,14,4)`	Extract the next four characters into local variable #LV3. (Appendix I Section 7.4)
`FD TESTFILE LABEL RECORD STANDARD` `  VALUE OF ID "#LV2#LV3"`	Generate two expansion time statements. (Appendix I Section 5)
`%END`	End of macro definition (Appendix I Section 3)
`%%%%%%%%`	Delimiter for %FILE statement. (Appendix I Section 6.5)
`%LOAD,TESTRUN$`	Load and validate the contents of the TESTRUN subfile which contains the macro FILECHECK. (Appendix I Section 6.7)
`%  FILECHECK`	Call the FILECHECK macro (Appendix I Section 4)
`*FILEPAYROLLDATA`	Request input record from the user.
`%END` `%SAVE,1,COBOLPROG$`	Terminate evaluation and append the generated statements to the COBOLPROG subfile. (Appendix I Section 6.3 and 6.11)
`%FINISH`	Terminate PG/1 macro processor run. (Appendix I Section 6.4)

When expanded the statements generated and appended to the COBOLPROG subfile will be as follows:

```
FD TESTFILE LABEL RECORD STANDARD
    VALUE OF ID "PAYROLLDATA "
```

Example 2.

This example shows the statements for defining and executing the INSERT macro which inserts the character supplied as an argument into three generated expansion-time statements.

```
%MACRO.                          Initialise the PG/1 system.
%BEGIN                           (Appendix I Sections 6.1 and 6.2)

%DEF  INSERT@@                   Define the INSERT macro with one
                                 argument.  (Appendix I Section 3)

      @1@FILE,0,GROWFILE$        Generate three expansion-time
      @1@DEF  GROWMACRO          statements which contain the macro
      @1@     LABELOFF           argument.  (Appendix I Section 5)

%END                             End of INSERT macro definition.
                                 (Appendix I Section 3)

%     INSERT%                    Call the INSERT macro using % as the
                                 argument character.
                                 (Appendix I Section 4)

%END                             Terminate evaluation and print the
%PRINT                           generated statements on the user's
                                 output device.
                                 (Appendix I Sections 6.3 and 6.11)

%FINISH                          Terminate the PG/1 macro processor run.
                                 (Appendix I Section 6.4)
```

When printed the generated statements will be as follows:

```
%FILE,0,GROWFILE$
%DEF  GROWMACRO
%     LABELOFF
```

PG/1 puts the items generated into a buffer until the run terminates.

2.3 FILETAB

2.3.1 Introduction

Report writer programs are designed to print out an analysis of data located on one or more files. The data will usually be in some sequence of keys and the report will consist of totals or analyses performed on various groups of data records, each analysis or total being produced when a key change occurs. As input to the report program the user specifies the format of the files concerned, the details of the format and contents of the printed report and any rules for creating totals etc. Report writer programs are usually applied to relatively long runs of relatively straight forward data processing.

2.3.2 Features of Filetab

The NCC Filetab system is a general purpose tabulator and report printing system. It is designed to be such that non-technical staff with no programming knowledge may specify the required report.

All user requirements including the format of output records are specified by means of directive and parameter records. A single character is used to identify the way in which a data field is processed by the system and also serves to identify the contents of the data field in subsequent parameters. The Filetab system is essentially an interpreter in that it reads the parameter records, translates them into an appropriate internal language and then executes the internal program one step at a time.

The Filetab system accepts data from input files on cards, magnetic tape and disc for serial processing. Only the fields in the input data files required in the output need be identified to the system. The features available permit the user to accumulate and print decimal, binary and sterling fields and

information from any field may be transferred to the output report.

The parameters defining the report allow the user to specify a simple list of one or more print lines per record with totals at control changes. Alternatively a 'totals only' tabulation of printing when control changes occur may be requested. The page layout may include a report title, page heading and control break headings. The page number, current date and time, descriptive literals and any input field may appear in an output line or heading. Where desired fields may be edited.

The full Filetab facilities are very comprehensive but the program may be used at two levels of complexity. The lower level permits a complete data file to be processed in order to produce a report. At the higher level, records may be selected, additional processing specified and subsiduary files input and/or created. This higher level processing is specified in the form of decision table directives which may be entered at five so called decision points in the processing, e.g. immediately after reading a record from the main input data file, before printing a line of output.

The Filetab directives are written in free format and may contain special items of information called parameters which are separated by visible spaces. Many of the operands are optional and some directives may be omitted from the set. Where operands and directives are omitted, previously defined default values are assumed.

2.3.3 Selected features

For the purpose of this study a subset of the lower level Filetab facilities were selected for implementation, sufficient to provide the user with a simple flexible and useful report writing tool.

Of the Filetab features available only those concerned with the specification of a Main data file and the simpler options of the Report format specification were considered. The Filetab directive statements for these limited features provide adequate information from which a complete COBOL report program can be generated. Although the use of auxillary Input and Output files, Data Selection and/or Editing and Miscellaneous Filetab options were excluded from the preliminary study investigations, some are covered in the later part of the project (Chapter 5).

Filetab directives may have either the * or the # symbol as the first character, but, for this study, only * was permitted.

Options from the following Filetab directives were selected for implementation:

*FILE	(Appendix II Section 3.1)
*INL	(Appendix II Section 3.2)
*TITLE	(Appendix II Section 3.3)
*HEAD	(Appendix II Section 3.4)
*OUT	(Appendix II Section 3.5)
* comment	(Appendix II Section 3.6)
*GO	(Appendix II Section 3.7)

A input sequence for Filetab directives is laid down but, as in this study error handling was minimal, the input order was relaxed save that the *GO directive had to be the last directive for a run.

At this stage in the project program of work only the translation process itself was of interest, so the investigation was limited to see how valid statements could be used to generate a COBOL program. Error checking and the handling of invalid user statements are studied later in the project.

In this study default values for some missing parameters in the Filetab directive were assumed, but no attempt to set default values for missing directives as a whole was made.

In Appendix II only those Filetab language features selected for implementation in this study are described. The number and ranges of parameters which may be used for specific purposes have in some cases been restricted below those normally available in Filetab. Full details of all Filetab facilities are to be found in the appropriate NCC manual [7].

2.3.4 A sample of Filetab

The way in which Filetab directives are used to specify a report is shown in the following example where it is desired to read, extract, total and print data from a file on magnetic tape named STORES-DATA.

The key field positions in each record of the file in major to minor key order occupy positions 0 to 1, 2 to 5 and 6 respectively. In addition to these items, the description data from positions 7 to 18 of each record is to be printed, while the quantity data which occupies positions 20 to 22 is to be both accumulated and printed. The record format illustrated below shows the field specification character assigned to each report field, shaded fields do not feature in the report.

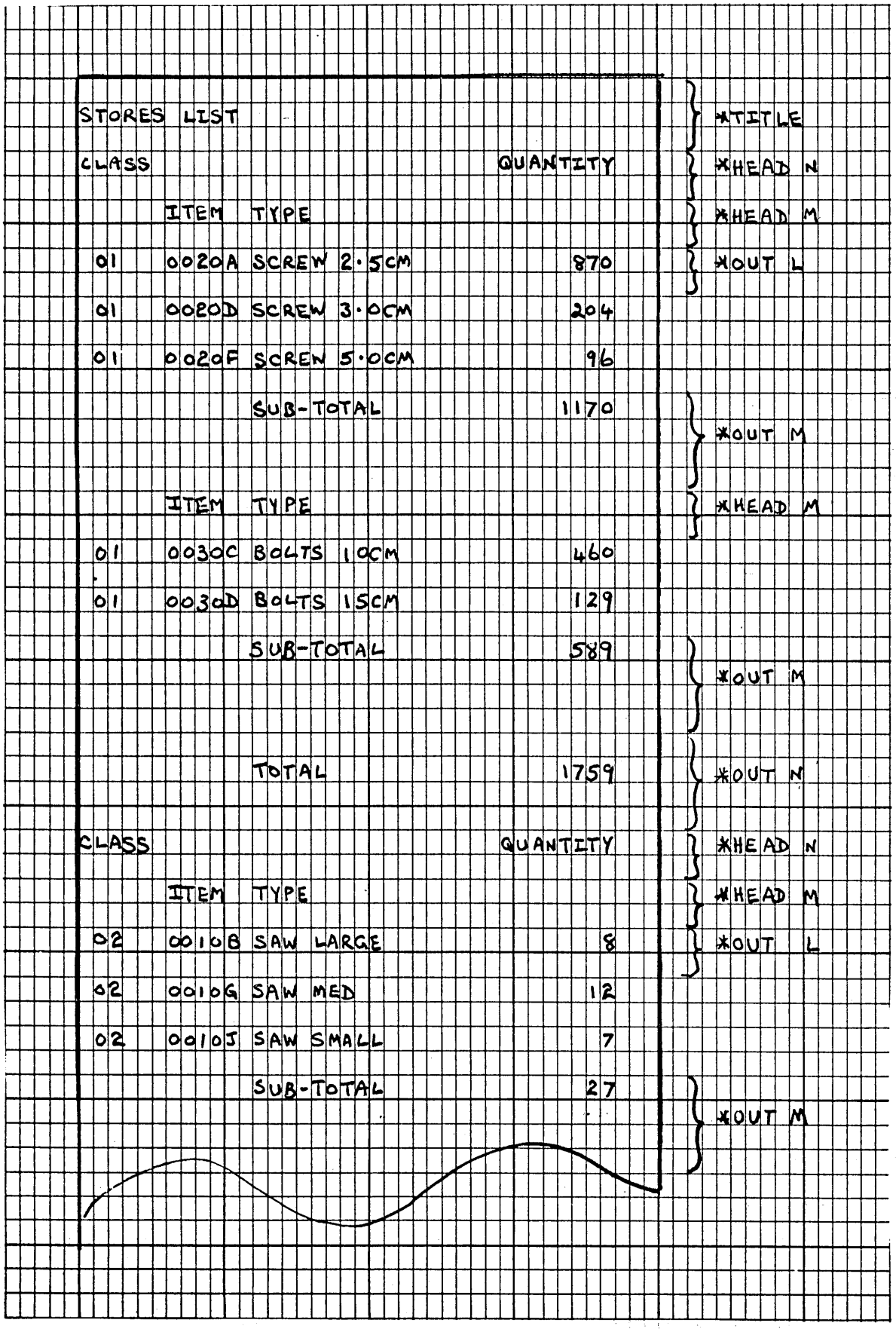
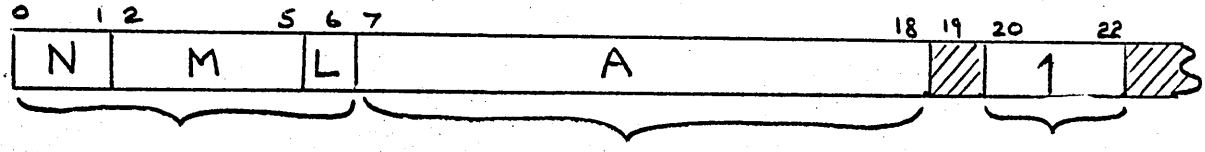


Figure 2.1 Report layout for Filetab sample



Sequence keys
CONTROL
fields

Item description
TRANSFER
fields

Quantity
TOTALLING
field

Figure 2.1 illustrates the layout of the desired report, which is to have a title and have the lines of the output listing separated by control break headings and totalling lines. The latter two types of output are printed when a sequence break (Appendix II Section 1) in the input data for a non-minor key field is detected. The totalling lines contain the accumulated totals for the data prior to the sequence break and the control break headings provide the headings for the data records following the sequence break. The notes at the right hand side of the figure indicate which report lines are specified by which Filetab directive.

The Filetab directives for producing the report are shown below:

```
*FILE MT STORES-DATA
*INL
 L 6/1, M 2/4, N 0/2, A 7/12, 1 20/3
*TITLE 2,1
STORES LIST
*HEAD M 1,1
      ITEM  TYPE
*HEAD N 1,1
CLASS                              QUANTITY
*OUT L 1,1
 NN    MMMML AAAAAAAAAAAA              111
*OUT M 1,3
           'SUB-TOTAL'             1111111
*OUT N 2,2
           'TOTAL'                 1111111
*GO
```

The *FILE directive specifies that the STORES-DATA file is on magnetic tape. The parameters of the *INL directive relate the field specifying characters to the actual position of the field within the record. All the fields in the example are specified using the start position and length information.

The *TITLE directive specifies the line spacing before and after the report title line. The text and position of the title within the print line are indicated by the contents of the following parameter record. The headings to be output for each new value of the M and N control fields are specified by the *HEAD M and *HEAD N directives. Their format and parameter records are similar to that used for the *TITLE directive. In this example both headings contain only text information.

The format for listing the input data is specified by the *OUT L directive and its following parameter record. Again the directive record specifies details of the line spacing before and after the print line. The field specifying characters in the parameter record indicate both the field to be printed and the actual positions it is to occupy. In this example the input data is listed without any additional text.

The *OUT M and *OUT N directives specify the format of totalling output to be printed when a change in the input value of the M and N control fields, respectively, are detected. The directive record indicates the line spacing required before and after the print line, whose format is specified in the following parameter record. The totalling field specifier in the parameter record indicates the print positions to be occupied by the accumulated total. In this example the totals at each control level are accompanied by text information. The latter is coded in the desired print positions and enclosed in quotation marks which do not appear in the printed report.

The end of the Filetab specification is indicated by the presence of the *GO directive.

CHAPTER 3

DEVELOPMENT OF A FILETAB TO COBOL PROGRAM GENERATOR

3.1 INTRODUCTION

This chapter, supplemented by the material in Appendix III, describes the development of a Filetab to COBOL program generator using the PG/1 macro processor. The description covers the following main topics:

1. The initial approach to the problem by the analysis of information contained in Filetab directives and its relation to the divisions of the COBOL program.

2. The problems of storing and sequencing the generated COBOL statements.

3. The adoption of a three phase approach for the design of the system to generate and synthesize a complete COBOL program.

4. The break-down of a Filetab directive into COBOL statements using the *INL directive as an example.

5. The macro processing of Filetab directives including the identification of the directive, the initialisation processing and an example of parameter processing based on the *INL directive.

6. An assessment of the Filetab to COBOL generator in terms of the quality of the program generated, the influence of the problem specifying language and the limitations of the macro processor.

The chapter ends with a summary, appraisal and conclusions.

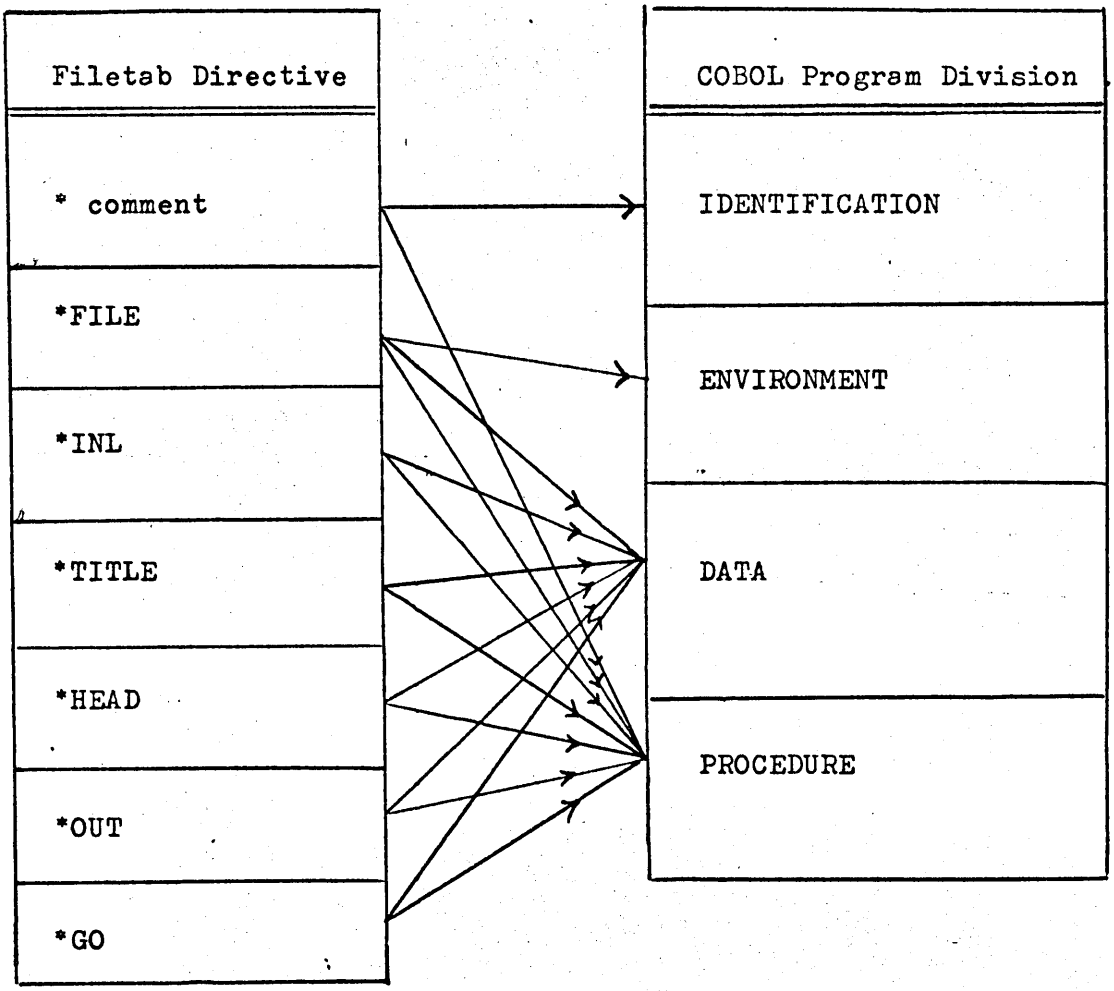


Figure 3.1 Contributions by Filetab directives to COBOL program divisions

3.2 INITIAL APPROACH

The approach to the problem of generating a COBOL program from the information supplied by Filetab directives was influenced by two factors. First the need to make best use of the PG/1 macro processor facilities, and secondly the desire to generate COBOL statements which could be structured into an efficient program.

Since COBOL programs are divided into four divisions, viz Identification, Environment, Data and Procedure, it was first necessary to analyse the various Filetab directives in order to see how the information they provide relates to the four COBOL divisions. As shown in Figure 3.1, each Filetab directive and its associated parameters provides information required to generate statements in two or more divisions of a COBOL program.

A more detailed analysis of Filetab statements revealed that the information from one directive can influence the contents of several paragraphs within the Procedure division. It is not therefore possible to generate the COBOL statements in the order in which they are required in the program. Some mechanism for storing and ordering the generated statements has to be found. The solution of these major problems greatly influenced the design of the Filetab to COBOL program generator.

3.3 STORING AND SEQUENCING GENERATED COBOL STATEMENTS

In this section solutions to the problems of storing and sequencing the generated COBOL statements using the PG/1 macro processor facilities are discussed. Although the following four solutions were considered, only the last was regarded as being practical:

1. Use of SAVE-blocks.
2. Use of %SAVE and %LOAD.

3. The three phase system using data subfiles.

4. The three phase system using 'grown' macros.

3.3.1 Use of SAVE-blocks

The PG/1 macro-time statements SAVE, ENDSAVE and COPY were first considered as a means of providing temporary intermediate storage for the generated COBOL statements by the use of SAVE-blocks (Appendix I Sections 7.7, 7.9 and 7.21). They were, however, rejected because with the existing processor it is not possible to append data to that already in an existing SAVE-block. A new SAVE-block would therefore be required each time a generated COBOL statement was not destined to follow sequentially after its predecessor. This would lead to unwieldy processing in order to recover data from the many SAVE-blocks in the sequence required for the COBOL program.

Sequencing is not the only problem, for SAVE-blocks are part of the stack mechanism of the macro processor and therefore take up space which could be used for other purposes. With a verbose language like COBOL the contents of the SAVE-blocks would take up too much stack space.

3.3.2 Use of %SAVE and %LOAD

As the internal storage of generated statements proved impractical, attention was turned to the system macros %SAVE and %LOAD. They provide a means of access to and retrieval from a disc file storage system associated with the processor (Appendix I Sections 1, 6.7 and 6.11).

The %SAVE system macro causes the contents of the output stack to be stored in the referenced subfile. Depending on the value of a parameter storing starts at the beginning of the

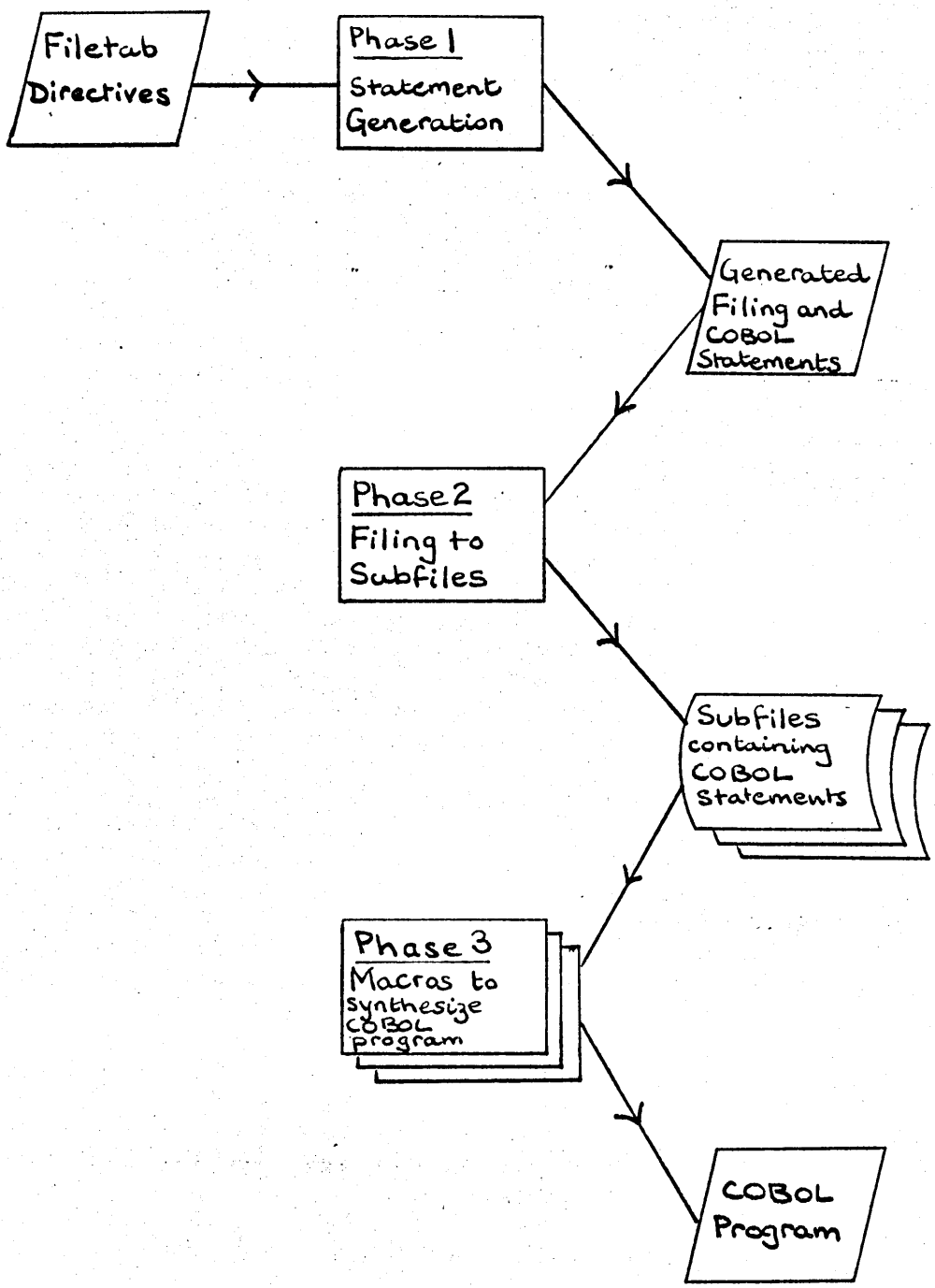


Figure 3.2 The three phase system using data subfiles

subfile or immediately after the present subfile contents. However, system macros cannot appear between the %DEF and %END statements which delimit a macro definition. To use the %SAVE command directly would mean devising many small macro definitions and requiring the user to sequence the loading and calls to each by means of appropriate %LOAD and %SAVE commands.

e.g.

```
%LOAD,MACRO1$                  Load and call macro MACRO1.
%     MACRO1
%END
%SAVE,0,INPUTREC$              Save statements generated by MACRO1
                               at the beginning of the INPUTREC
                               subfile.

%LOAD,MACRO2$                  Load and call MACRO2.
%     MACRO2
%END
%SAVE,0,ADDPARA$               Save statements generated by MACRO2
                               at the beginning of the ADDPARA
                               subfile.

%LOAD,MACRO3$                  Load and call macro MACRO3.
%     MACRO3
%END
%SAVE,1,INPUTREC$              Append the statements generated by
                               MACRO3 to those already in the
                               INPUTREC subfile.
```

and so on ...

This approach was rejected as too cumbersome and error prone for even an experienced user (let alone the inexperienced user).

3.3.3 The three phase system using data subfiles

A solution to the sequencing problem can be reached by using the %FILE command and adopting a three phase approach for the generation of the complete COBOL program. The three phases illustrated in Figure 3.2 cover the following topics:

1. Statement generation.
2. Filing the generated statements.
3. Synthesis of the complete COBOL program.

The first phase requires that the macro definitions generating the COBOL statements should also generate their system filing commands. Thus each group of COBOL statements in the output stack would be contained between a %FILE command specifying the destination subfile and the associated terminator record of eight '%' characters (Appendix I Section 6.5). For example the statements generated in the macro processor output stack have the following form:

```
%FILE,0,INPUTREC%
    |                          COBOL statements for defining record
    |                          fields which are destined for the
    |                          INPUTREC subfile.
    |
%%%%%%%%
%FILE,0,ADDPARA%
    |                          COBOL statements for accumulating
    |                          totals which are destined for the
    |                          ADDPARA subfile.
    |
%%%%%%%%
%FILE,1,INPUTREC%
    |                          Further COBOL statements for defining
    |                          input record fields which are destined
    |                          to be appended to the INPUTREC subfile.
    |
%%%%%%%%
```

and so on ...

The contents of the output stack is saved for use during the second phase.

During the second phase the generated statements are loaded back into the system so that the generated filing statements can be obeyed. The generated COBOL statements are thus filed in the specified subfiles.

The third phase is concerned with the synthesis of the complete COBOL program from a basic skeleton and the generated statements stored in the various subfiles. To retrieve the generated COBOL statements from the subfiles the %LOAD command must be used, but this is a system macro which cannot be used from within a macro definition. It is therefore necessary to intersperce %LOAD commands between many small macros in order to

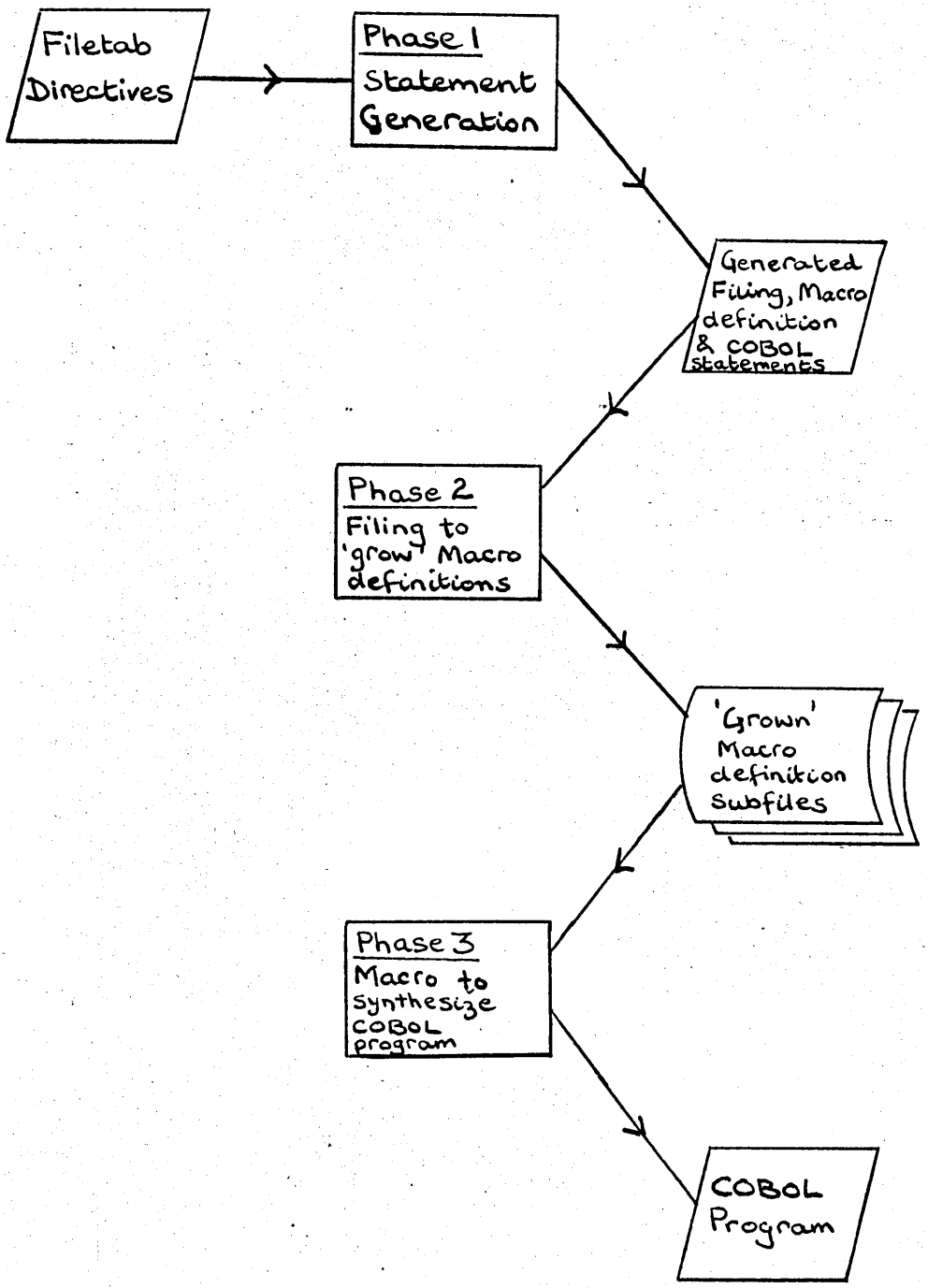


Figure 3.3 The three phase system using 'grown' macros

generate the complete COBOL program.

e.g.

%LOAD,PROGRAMPART1$ % PROGRAMPART1	Load and call the PROGRAMPART1 macro which generates the first part of the COBOL program.
%LOAD,INPUTREC$	Load and include the COBOL statements stored in the INPUTREC subfile.
%LOAD,PROGRAMPART2$ % PROGRAMPART2	Load and call the PROGRAMPART2 macro which generates the next part of the COBOL program.
%LOAD,ADDPARA$	Load and include the COBOL statements stored in the ADDPARA subfile.
%LOAD,PROGRAMPART3$ % PROGRAMPART3	

and so on ....

Although the storage problem is overcome by this method, this approach to the sequencing problem is both tedious and error prone.

3.3.4 The three phase system using 'grown' macros

When a subfile containing data is loaded the PG/1 system transfers its contents to the output stack from where it cannot be accessed from within a macro definition. In contrast, if a subfile containing a macro definition is loaded, the macro is compiled and stored in the definition stack. Access to one macro from within another is possible by means of the PG/1 macro nesting facility (Appendix I Section 4).

By changing the subfiles used in the three phase approach outlined in Section 3.3.3 from data subfiles to simple macro definition subfiles, the macro nesting facility can be used to simplify the task of synthesizing the complete COBOL program. The three phase generation of a COBOL program from Filetab directives illustrated in Figure 3.3 may be summarized as follows:

1. The input of data in Filetab directive format and the generation of COBOL, system macro and macro-time statements.

2. The filing of the generated statements in the appropriate subfiles in order to 'grow' simple macro definitions.

3. The synthesis of the complete COBOL program using a macro definition which makes nested calls to the macros 'grown' during the previous phase.

When the data subfiles are changed to simple macro definitions the macro bodies consist largely of COBOL statements. In addition to the COBOL and system filing statements, the macro defining statements, %DEF and %END, and some simple macro-time statements are also generated during phase 1. The following outline illustrates the phase 1 contents of the output stack for growing the INPUTREC macro definition in the subfile of the same name:

```
%FILE,0,INPUTREC%
%DEF  INPUTREC          System macro statements defining macro
      |                 INPUTREC and possibly some macro-time
      |                 and COBOL statements.
      |
%%%%%%%%
      |
      |
%FILE,1,INPUTREC%
      |                 More COBOL statements for inclusion
      |                 in the body of the INPUTREC macro.
      |
%%%%%%%%
      |
      |
%FILE,1,INPUTREC%
      |                 Some further COBOL and macro-time
      |                 statements followed by the system
      |                 macro statement for completing the
%END                    INPUTREC macro.
%%%%%%%%
```

and so on ...

During the second phase the generated statements are loaded back into the system so that the filing commands can be obeyed. The generated macro definition, macro-time and COBOL statements are thus filed in the specified macro definition subfile.

The task of synthesizing the complete COBOL program from the macros 'grown' during the first two phases is no longer

complicated from the user's point of view. It consists of loading the required macros and initiating a call to the macro definition which generates the program shell containing mainly static information. This macro, called GOPART2, automatically makes nested calls to the 'grown' macros whose contents depend entirely on the options specified in the original Filetab directives.

e.g.

```
%LOAD,INPUTREC,ADDPARA,.....,....,ß    Load 'grown'macros.

%LOAD,GOPART2ß                         Load and call the macro
%     GOPART2                          which generates the shell of
                                       the COBOL program.
```

The GOPART2 macro has the following form:

```
%DEF  GOPART2                  Define program generating macro.
      |
      |                        Generate part of the COBOL program
      |                        shell.
      |
      [INPUTREC]               Nested call to the 'grown' macro whose
                               body contains the COBOL statements
                               defining the input record format.
      |
      |                        Generate more of the COBOL program
      |                        shell.
      |
      [ADDPARA]                Nested call to the 'grown' macro whose
                               body contains the COBOL arithmetic
                               processing statements.
      |
      |
%END                           End of macro definition.
```

Table 3.1 'Grown' macros

Macro name	Contents	Division
PART1	Statements specifying the COBOL compiler options.	Steering Lines
CONSTANTS	Macro-time statements restoring the values of certain global and string variables to those set during the first phase of the generating system.	Not applicable
INPUTREC	Input file data record descriptions.	Data Division
CTRLBRKE	Data descriptions for each control field used in the report.	
TITLES	Data descriptions for the report title records.	
HEADINGS	Data descriptions for the control break heading records.	
OUTREC	Data descriptions for detail and control total lines.	
SAVETOTL	Data descriptions for each totalling field used in the report.	
NOTEPARA	COBOL NOTE statement containing Filetab comment records.	Procedure Division
ADDPARA	Statements to add totalling fields in the input record to the corresponding total field at the lowest control level.	
TITLEPAR	Write statements to output the report title lines.	
PAGEPARA	Statements which initiate the writing of control group headings.	
MOVEPARA	Statements to move fields from the input record to the detail line records.	
WRITEPAR	Statements which detect the need for a new page and write out the detail lines for the current input record.	
BREAKPAR	Paragraphs containing statements to detect and process a sequence break in the input record control fields.	

continued

3.4 THE DESIGN OF THE COBOL PROGRAM GENERATOR

In this section further consideration is given to the design of the Filetab to COBOL program generator in terms of the three phases outlined in Section 3.3.4.

3.4.1 Phase 1 - Statement generation

A detailed analysis of the data contained in the Filetab directives showed that there were fifteen groups into which the generated statements would fall. Six were associated with the Data division of the program, while the remaining nine were associated with the Procedure division. Each group of generated statements would therefore need to be 'grown' into a separate macro definition.

In addition two further macros are required, one to pass global and string variables between phases 1 and 3, and another to contain Steering Lines data. Steering Lines are parameters which specify to an ICL 1900 series COBOL compiler the options required. Table 3.1 shows the name and contents of each of the seventeen macro definitions whose statements are generated during the first phase of the COBOL generating system.

Figure 3.4 shows to which macro definitions each Filetab directive may contribute and how, in turn, the former contribute to the various Divisions and Sections of the COBOL program. For example, the following *INL directive contains information which affects the statements generated for the input record description (INPUTREC macro), the data description for totalling fields (SAVETOTL macro), the data descriptions for the sequence control fields (CTRLBRKE macro) and the processing of totalling fields (ADDPARA macro).

Table 3.1 continued

Macro name	Contents	Division
FINALPAR	Statements which initiate the writing of the final control total lines at the end of the report.	Procedure Division
OTHERPAR	Paragraphs for testing if a new control heading is required, writing control heading and control total lines.	

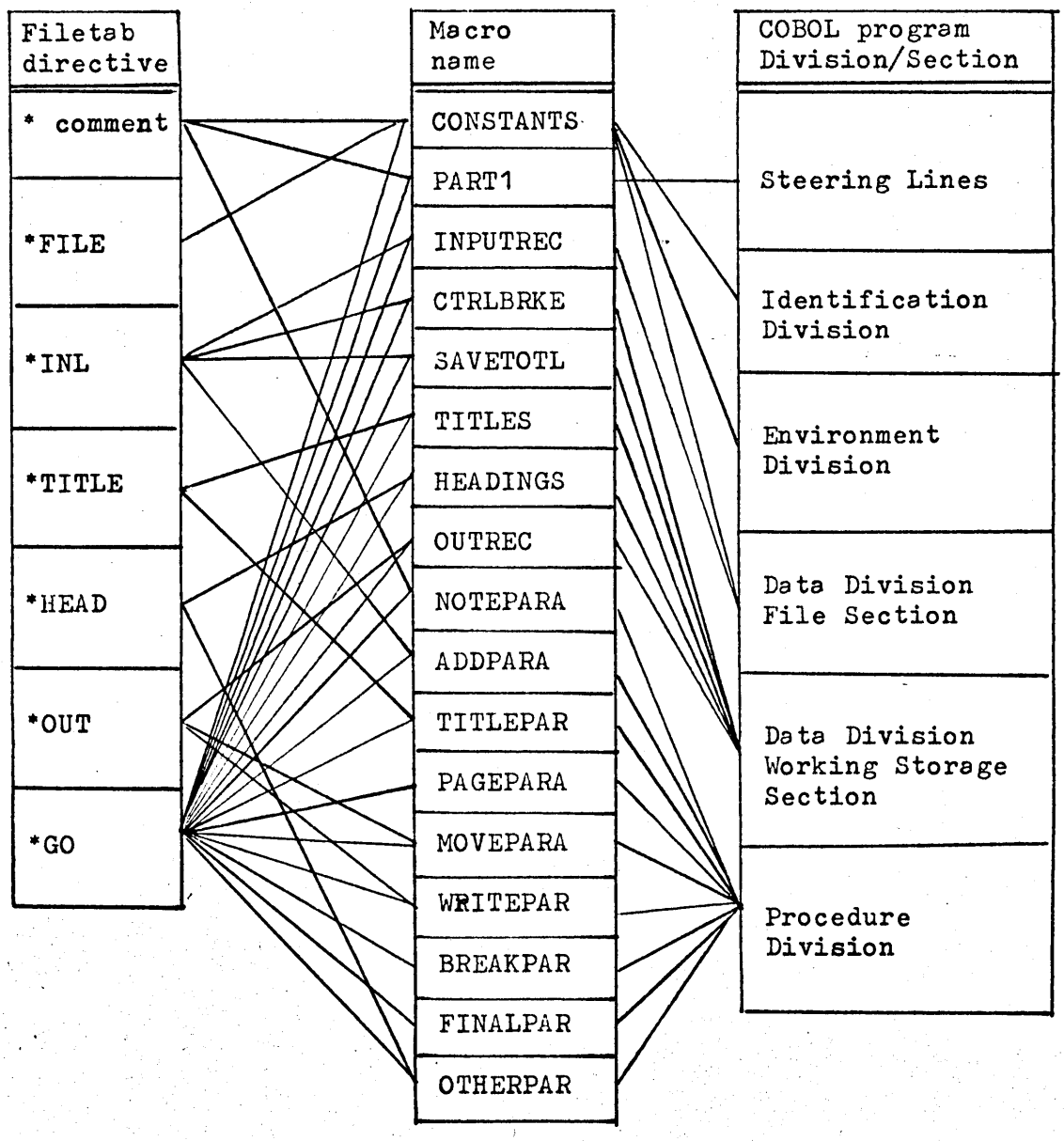


Figure 3.4 Filetab directive contributions to 'grown' macros and the generated COBOL program

```
*INL
 L 5/2, M 1/4, A 8/10, 1 20/3
```

The number of macro definitions which are influenced by certain directives depends on the parameters specified in the directive by the user. If, for example, the totalling field was omitted from the above *INL directive, COBOL statements would not be generated for the SAVETOTL and ADDPARA macros.

3.4.2 Phase 2 - Forms of the 'grown'macros

In order to avoid storing the Filetab directives only one pass is made over the input statements during phase 1 of the generating system. This means that the bodies of the macros 'grown' during the second phase of the system take one of the following forms:

1. Contain no generated COBOL statements at all.
2. Contain simple Procedure division paragraphs consisting of an EXIT statement.
3. Contain the whole or part of a Procedure division paragraph which defines some processing.
4. Contain Data division statements which define input or output records or Working Storage items.
5. Contain the Steering Lines necessary to compile the generated COBOL program on an ICL 1900 series computer.
6. Contain macro-time statements for setting up global and string constants which are needed in the third phase of the generating system.

3.4.3 Phase 3 - Skeleton COBOL program

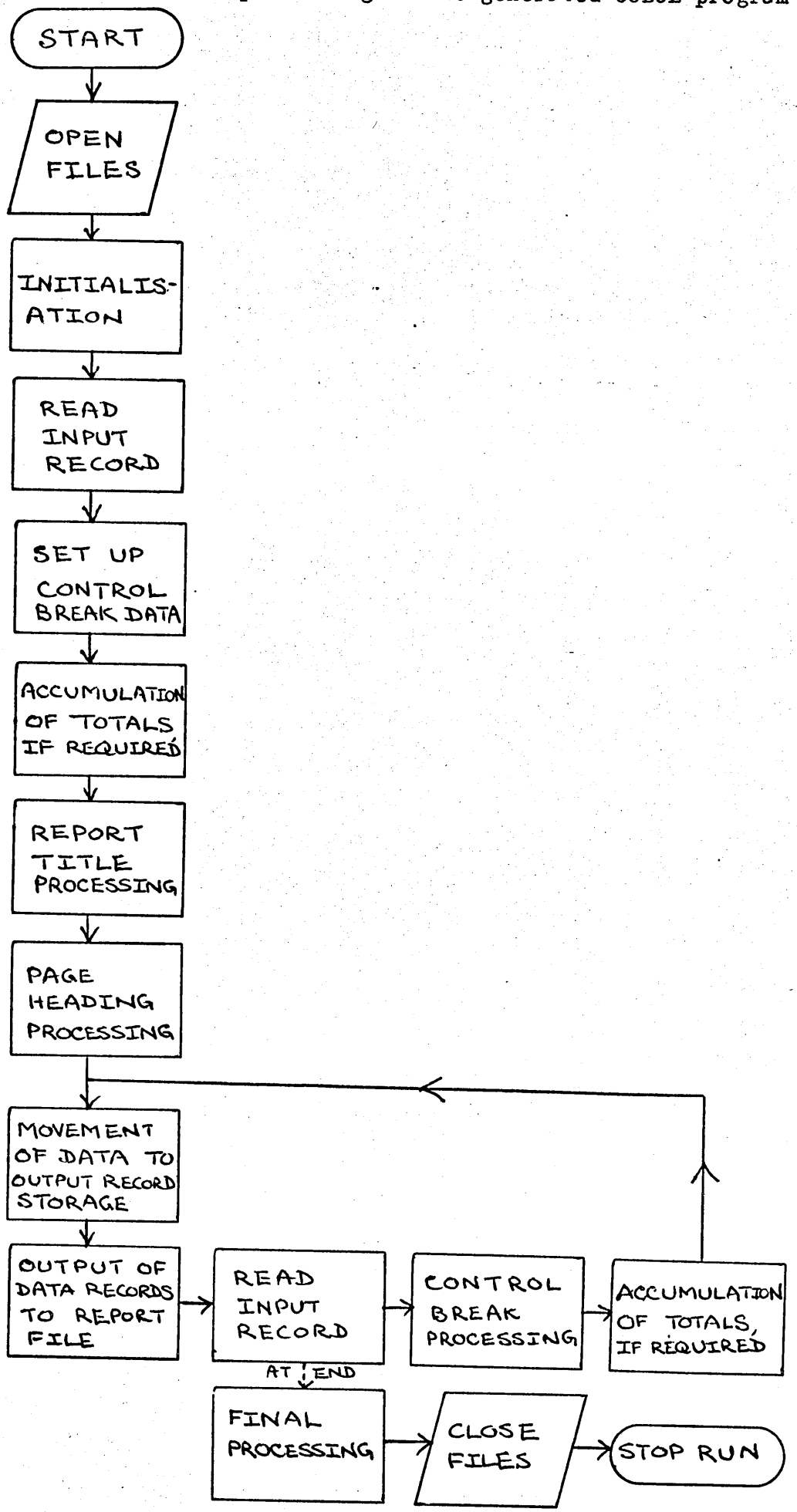
The main aim when designing the skeleton program was to keep the logical flow simple, but at the same time use structures which can accomodate the many variations likely to be specified by the Filetab input data. To this end the Procedure division of the program was largely built up from a series of PERFORM statements. These PERFORM statements refer to paragraphs wholly or partly contained in the macros 'grown' during the first two phases of the system. This approach is similar to the extensive use of parameterized subroutines in the FORTRAN program generator (3.8).

In some instances a PERFORM statement is only generated if a global variable has previously been set to indicate that the required statements have been generated (3.4.2 Case 1). In other instances it is possible to unconditionally include a PERFORM statement in the generated program, because the paragraph referenced contains the generated statements to carry out the processing, or it contains an EXIT statement if no processing is required (3.4.2 Cases 2 and 3).

The outline flowchart for the shell of the Procedure division of the generated COBOL program is illustrated in Figure 3.5. The listing of the GOPART2 macro, which generates the complete COBOL program by making nested calls to the 'grown' macros, is included in the separate folder (Item 3).

In the Data division, Working Storage section of the generated COBOL program additional FILLER fields are included in certain group data descriptions. They are present in order to avoid compilation diagnostics when the 'grown' macro contains no generated statements for the lower levels of the group. For example, when there are no control totals to be accumulated the group description will appear as follows:

Figure 3.5 Outline of processing in the generated COBOL program



```
01  CONTROL-TOTALS.
    02  FILLER PICTURE X.
```

The WRITE FROM option of the WRITE verb is used in the generated program so that literals in the various record types can be set up once and for all. Only variable data need then be moved into position prior to writing out the record.

3.5 EXAMPLE OF THE BREAK-DOWN OF A FILETAB DIRECTIVE INTO COBOL STATEMENTS

By taking the *INL filetab directive as an example this section serves to show how the elements in a parameter are translated into COBOL. It also emphasises the volume and variety of COBOL statements which may be generated from the information contained in a single Filetab directive. Notes describing the generation of COBOL statements from the other Filetab directives implemented in this study are given in Appendix III.

An *INLIST directive defining two control level fields, a transfer and a totalling field of the form shown below will require the generation of COBOL statements for inclusion in four macros, namely INPUTREC, CTRLBRKE, SAVETOTL and ADDPARA. Consider for example:

```
*INL
 L 4/2, M 0/4, A 7/10, 1 19/3
```

The fields in a COBOL record description are described in start position order. In contrast Filetab does not require the fields to be specified in the order in which they appear in the input record. Both Filetab and COBOL allow fields to be redefined and such fields may overlap others. The greater flexibility in Filetab is overcome by making each Filetab field generate a complete new record description which redefines the previous one. Thus each COBOL record description appears to contain only one named field with the unused positions in the record described by

FILLER fields.

Magnetic tape files used on an ICL 1900 computer contain a sentinel record which, among other details, includes the maximum record length used in the file. This information is used by the COBOL housekeeping routines and overrules that specified in the COBOL program. Thus, to prevent execution errors caused by a conflict between sentinel and program data, a standard maximum input record length of 2048 characters was adopted. This figure is in line with the ICL conventions for COBOL programs of this size and type using magnetic tape files.

Since COBOL data-names cannot be entirely numeric the Filetab totalling field specifiers are prefixed by the letter A when COBOL program statements to process them are generated. Other types of field specifiers remain unchanged when used as COBOL data-names.

The lowest level control field, L, only contributes to the Data division input record specifications, which are filed in the INPUTREC macro. It causes the following statements to be generated:

```
02  FILLER-1 REDEFINES INREC.
03  FILLER PICTURE X(4).
03  L PICTURE X(2).
03  FILLER PICTURE X(2).
03  FILLER PICTURE X(120) OCCURS 17.
```

The ICL 1900 COBOL compiler imposes a maximum size of 120 characters on an alphanumeric field, hence the need to use the OCCURS clause and have two FILLER statements to fill out the record to the correct length.

The M field, being a control field not of the lowest level, contributes COBOL statements to both the INPUTREC and CTRLBRKE macros. The latter macro contains statements used to build up a group structure in the Data division, which is used by the Procedure division to detect a sequence break in the control

fields.

Thus control field M will cause the following statements to be generated for inclusion in the INPUTREC macro:

```
02  FILLER-2 REDEFINES FILLER-1.
03  M PICTURE X(4).
03  FILLER PICTURE X(4).
03  FILLER PICTURE X(120) OCCURS 17.
```

Only one statement is generated by this control field for inclusion in the CTRLBRKE macro and this is as follows:

```
02  M PICTURE X(4).
```

Transfer field A is similar to the lowest contol level field in that it only causes statements to be generated for inclusion in the INPUTREC macro.

Viz,

```
02  FILLER-3 REDEFINES FILLER-2.
03  FILLER PICTURE X(7).
03  A PICTURE X(10).
03  FILLER PICTURE X(111).
03  FILLER PICTURE X(120) OCCURS 16.
```

The totalling field, 1, contributes generated statements to three macros, namely INPUTREC, SAVETOTL and ADDPARA. The SAVTOTL macro is used to store statements required by the Data division for defining totalling fields for each control level of the report, except the minor control level. A Procedure division statement for the accumulation of the control total is required and this is generated for inclusion in a macro called ADDPARA. Thus the Filetab field specification 1 19/3 contributes the following statements to the macros indicated below:

INPUTREC macro:

```
02  FILLER-4 REDEFINES FILLER-3.
03  FILLER PICTURE X(19).
03  A1 PICTURE 9(3).
03  FILLER PICTURE X(106).
03  FILLER PICTURE X(120) OCCURS 16.
```

SAVETOTL macro:

```
03  A1 PICTURE 9(15) COMPUTATIONAL VALUE ZERO.
```

ADDPARA macro:

ADD A1 IN INREC TO A1 IN M-LEVEL.

While the extensive use of the COBOL REDEFINES facility clearly affects the program compilation time, its effect on program execution time is minimal.

3.6 THE MACRO PROCESSING OF FILETAB DIRECTIVES

The design of COBOLGEN, the macro for processing the Filetab directives and generating the statements which, in phase 2, are filed to 'grow' macros, is now considered. The following topics are discussed:

1. Outline processing for the identification of Filetab directives.
2. Initialisation processing.
3. Outline processing of Filetab directive parameters.

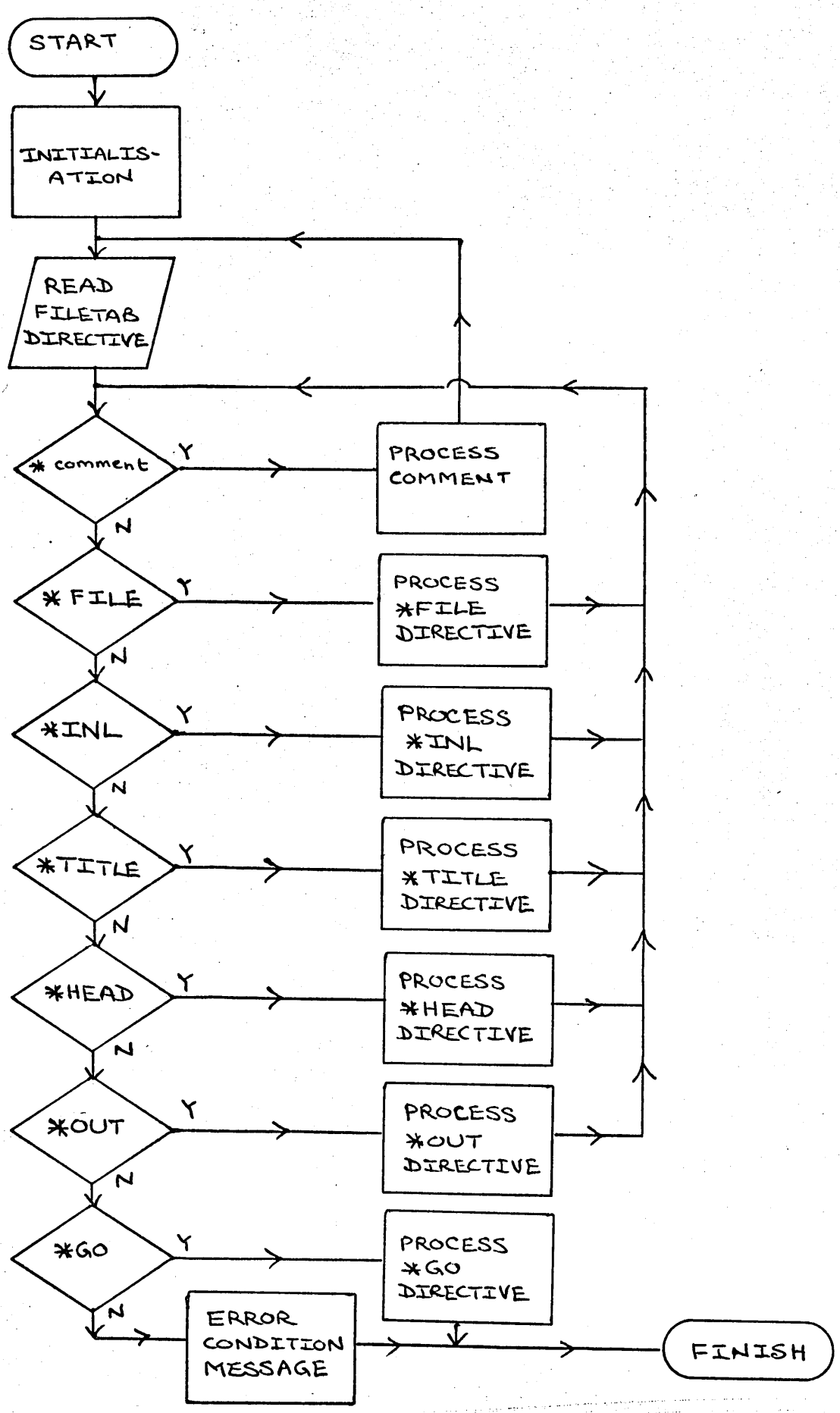
3.6.1 Outline processing for the identification of Filetab parameters.

As shown in Figure 3.6, a modular approach was used for the design of the COBOLGEN macro definition, which generates the COBOL statements from the Filetab directives.

The Initialisation section (3.6.2) is followed by a READ operation which inputs a Filetab directive. In the next section the directive, which may be one of seven valid types, is identified. Control then passes to the section where the particular directive and its associated parameter records, if any, are processed.

The processing of the parameter records continues within each section until a new directive record, starting with an * character, is detected. Control then returns to the section which identifies the new directive.

Figure 3.6 Outline processing for Phase 1 of the Filetab to COBOL program generator



The exceptions to the above are the * comment and *GO directives. In the case of comments they are processed one at a time with control returning to the first READ operation. When the *GO directive is detected the outstanding COBOL and macro definition statements are generated, thus completing the first phase of the generating system.

A listing of the macro-time statements for the identification of Filetab directives is included in the separate folder (Item 1).

3.6.2 Initialisation processing

In order to 'grow' macro definitions it is necessary to be able to use the % ' and # characters in some of the generated statements. However, these characters have special meanings within the macro processor and are, respectively, the macro warning character, the literal delimiter and the label marker. Special processing is required in order to achieve their presence in the generated output. A common method for handling these special characters is not possible because of their different special meanings to the PG/1 macro processor.

The PG/1 macro processor stores macro definitions in core in an intermediate code which is executed when the macro is called. Text to be output by a macro definition is intersperced with the macro-time statements. In the execution phase a % character in the intermediate code indicates a call to a subroutine, hence the likelihood of confusion and error when the output text also contains % characters. To overcome this difficulty the % character is input to the macro definition in the form of an argument. Thus the COBOLGEN macro must be called by the following

statement:

```
%      COBOLGEN(%)
```

During the development of the COBOLGEN macro it was necessary to depart from the default value for the argument marker as the @ character was an operating system control character on the host computer. Instead the / character was defined as the macro argument marker using the %MACRO system macro (Appendix I Section 6.1). Wherever a % character is required in the expansion-time statements of the COBOLGEN macro the macro argument /1/ is used.

The quote character which is used by the macro processor to delimit alphanumeric literals also presents a problem when it is required in a statement to be generated. This problem was overcome by reading the quote character from an input record and storing it in a global variable called #GQUO. The record containing the quote character must follow immediately after the call to the COBOLGEN macro and precede the Filetab records in the input stream.

The # character is set up as an alphanumeric literal in global variable #GHATC. The name of this variable is specially chosen to have the full four characters after the G so that it can be placed immediately in front of a string of characters in an expansion-time statement. A shorter name causes the macro processor to interpret the beginning of the character string as part of the global variable name.

Statements destined for some of the macros to be 'grown' may be generated at various points within the COBOLGEN macro, depending on the Filetab directives submitted as input. In order to handle this situation three small routines were devised to generate the statements for filing and defining the macros to be 'grown'.

The first routine generates the %FILE and %DEF statements for the subfile whose name is contained in global variable #GFIL. A LABELOFF macro-time statement is also generated so that the first six characters of any generated statement which follows are not ignored (Appendix I Section 7.13).

```
%101  CONTINUE   :INITIALISE                Statement to label
                                            routine.

      /1/FILE,0,#GFIL$                      Expansion-time statements
      /1/DEF  #GFIL                         (within the text /1/ is
      /1/     LABELOFF                      equivalent to %).
      /1//1//1//1//1//1//1//1/
%
%     RETURN                                Return to calling
                                            routine.
```

The second routine generates the system macro statement necessary to append subsequently generated statements to an existing macro definition subfile. The subfile name is again contained in global variable #GFIL.

```
%102  CONTINUE   :APPEND                    Statement to label
                                            routine.

      /1/FILE,1,#GFIL$                      Expansion-time statement.

%     RETURN                                Return to calling
                                            routine.
```

The last of the basic service routines generates the filing statements necessary to append the final %END statement to the subfile containing the macro definition specified by the #GFIL global variable. It also generates the LABELON macro-time statement to negate the effect of the LABELOFF statement at the beginning of the 'grown'macro.

```
%104  CONTINUE   :FINALISE                  Statement to label
                                            routine.

      /1/FILE,1,#GFIL$                      Expansion-time statements
      /1/     LABELON
      /1/END
     /1//1//1//1//1//1//1//1/

%     RETURN                                Return to calling
                                            routine.
```

In addition to the processing to handle the special characters, the Initialisation section of the COBOLGEN macro causes the statements which initialise all the 'grown' macros to be generated. This latter processing consists of pairs of macro-time statements which set the name of the macro in global variable #GFIL and cause INITIALISE, the first of the above service routines, to be obeyed. Some of the 'grown' macro definitions have an associated global variable which is used to indicate whether or not the body of the 'grown' macro contains any generated COBOL statements (3.4.2 Case 1). These global variable indicators are set egual to zero during the Initialisation section of the COBOLGEN macro.

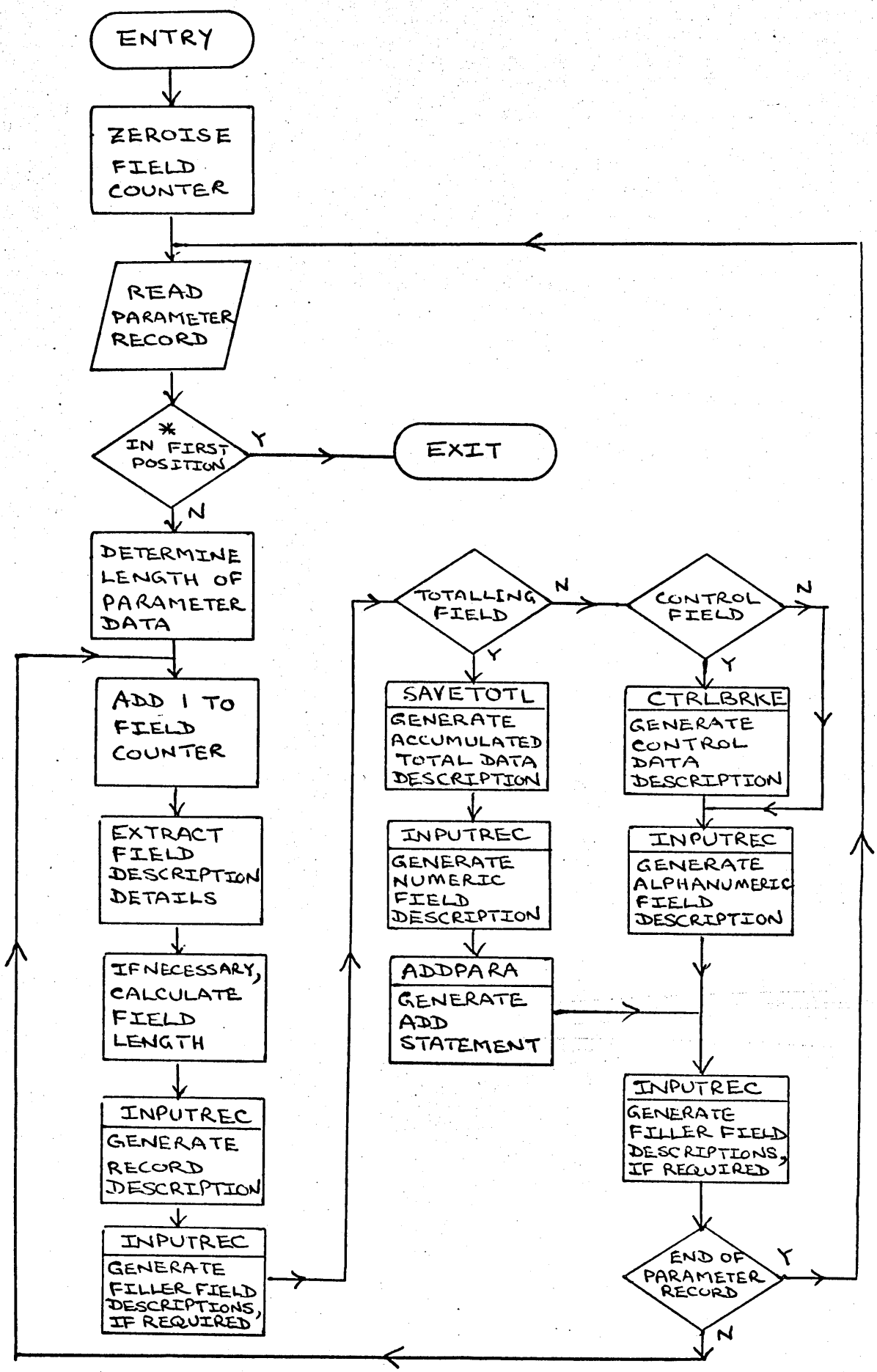
A listing of the Initialisation section of the COBOLGEN macro is included in the separate folder (Item 2).

3.6.3 Outline processing of Filetab directive parameters

The processing of Filetab directive parameters is illustrated by taking one example, namely the parameters of the *INL directive which was discussed in Section 3.5.

The flowchart in Figure 3.7 shows the outline processing for the Filetab *INL parameter records. Depending on the parameters data, this processing will generate COBOL, macro-time and system filing statements for one or more of the subfiles INPUTREC, SAVETO SAVETOTL, ADDPARA and CTRLBRKE (3.5). The APPEND service routine (3.6.2) is used to generate the filing commands which direct the generated COBOL statements to the desired subfile. It will be noted from Figure 3.7 that there are multiple call to append generated COBOL statements to the INPUTREC subfile and that these are intersperced with calls to append statements to other subfiles. This illustrates the convenience of the sequencing

Figure 3.7 Outline processing of Filetab *INL parameters



method adopted for the COBOL generating system (3.3.4).

In order to deal with the problem of overlapping fields and fields not specified in start position order, each Filetab field is made to generate a complete new record description which redefines the previous description (3.5). A count of input fields is maintained and is used in the nomenclature of the record descriptions when they are generated (Appendix III Section 4).

Parameter records are read and processed one at a time until a new Filetab directive record with an asterisk in the first position is detected. Control then passes to the macro-time statements which identify the directive (3.6.1).

The parameter record in the input buffer is squashed to remove imbedded spaces in order to simplify data extraction and to determine its length.

The field counter is incremented and the details for a field description are extracted (Appendix II Section 3.2.2). If the end position rather than field length was specified the latter is calculated for use when the COBOL field description is generated.

The COBOL statement defining the new record description is generated for filing in the INPUTREC subfile. Unless the current fields starts in the first position of the record, FILLER field description statements for the initial part of the record are generated. These too will be filed in the INPUTREC subfile.

If the current field is a totalling field a data description statement for the accumulated total is generated for filing in the SAVETOTL subfile. The input record numeric field description is then generated for filing in the INPUTREC subfile. Finally the ADD statement, which accumulates the total, is generated for inclusion in the ADDPARA subfile.

If the current field is a control field a control break data description is generated for inclusion in the CTRLBRKE subfile. Both control and transfer fields have an alphanumeric input record field description generated for filing in the INPUTREC subfile.

Unless the current field, regardless of type, ends in the last position of the record, FILLER field description statements are generated for the final part of the record. These will be filed in the INPUTREC subfile.

If, when the current field description has been processed, the input buffer data has been exhausted another parameter record is read. Otherwise the details for the next field description are processed.

Further details of the parameter processing, statements generated and macro-time variables used are given in Appendix III Section 3. A listing of the macro-time statements for processing *INL parameters is included in the separate folder (Item 5).

3.7 ASSESSMENT OF THE FILETAB TO COBOL PROGRAM GENERATOR

The processing described earlier in this chapter and that outlined in Appendix III demonstrates the feasibility of using the PG/1 macro processor to generate a complete syntactically correct COBOL program from a set of Filetab directives. At this stage we are not concerned with the full syntax checking of Filetab directives nor the semantics of the Filetab request. Some assessment of program size and efficiency, the elegance of the generated code, the influence of the problem specifying language and the limitations of the macro processor must, however, be made before the generation of COBOL programs by macro processor can be deemed a viable proposition.

3.7.1 Program size and efficiency

Some measure of the efficiency of the generated program can be assessed by comparing its run time statistics with those of a Filetab run on the same computer, using the same input data file with the same directive statements and producing an identical output report.

In a typical comparison exercise the following Filetab directives were used to generate a COBOL program:

```
* THIS IS A COMMENT
*TITLE 1,3
REPORT TITLE
TABN TO COBOL TEST
*FILE MT STUD-MAIN73
*HEAD M 1,1
CONTROL LEVEL M HEADING FIELD-1 FIELD-2 FIELD-3
*HEAD N 1,1
CONTROL LEVEL N HEADING
*INL
 L 7/1, M 6/1, N 4/2, A 0/4, B 4/4, 1 8/3
*OUT L 1,1
                        AAAA    BBBB        111
*OUT M 1,1
                        'SUB-TOTAL'     1111111
*OUT N 1,1
                        'TOTAL'         1111111
*GO
```

TABN, the ICL 1900 series version of the Filetab program, was allocated 19K words of storage on an ICL 1907 computer and and executed using the above directives. The data file contained 248 variable length records, the maximum size of which was 2048 characters. One second of Central Processor Unit (CPU) time was required to run the program, which used 296 write operations to print the report, list the directive statements and print the job statistics. In contrast TABC, the generated COBOL program consisting of 232 source records, required only 3½K words of storage on the same computer, but used two seconds of CPU for execution. The number of write operations required to produce an identical report and to print the job statistics rose to 557.

The significantly larger number of write operations required by the COBOL program is due to the inefficient method used to achieve the required spacing after any print group. The wasteful technique of printing a blank line after each print group needs to be replaced by the setting of a counter, which can be added to the ADVANCING count for the next WRITE statement. The process of printing the blank lines is a contributory factor in the higher usage of CPU time by the COBOL program. This latter statistic was, however, only available rounded to the nearest second and so was not a very sensitive measure of program efficiency.

The core requirements of the generated COBOL program compares favourably with those which would be required by a hand coded program, although the coding of the latter would be more elegant. Apart from the wasteful printing of blank lines, there are other areas where improvements could be made in the generated COBOL program. These would both improve the run time efficiency and reduce the compilation time by the use of fewer, shorter source language statements.

3.7.2 The elegance of the generated COBOL code

The program listing forms an important part of the documentation for a program. In the case of a generated program the listings of the input parameters and the generated source code are often the only pieces of documentation available. In such cases the elegance of the generated code is a contributory factor in the clarity of the program documentation.

The generation of the Data division input file record description is one area where an improvement could be made. The number of redefinitions could be reduced, if some attempt was made to relate each data field to the one that preceded it on the *INL parameter record. Thus, only when data fields overlapped, or were

not specified in start position order, would there be a need for a REDEFINES statement. Another opportunity for improvement occurs in the Procedure division of the generated program where, by sectionalising the paragraphs, a statement of the form:

PERFORM paragraph-name-1 THRU paragraph-name-2.

could be replaced by a statement of the form:

PERFORM section-name.

Although not shown up by the particular Filetab example quoted above, a deficiency exists in the method used by the COBOL program to detect the need for a new page when printing a group of output lines. The *HEAD L directive is used to specify, either explicitly or by default, the maximum number of lines per report page (Appendix II Section 3.4). The COBOL program, however, only tests the line count value prior to printing a group of output lines. Thus, if an output group consists of several lines, the page may turn out to have slightly more than the permitted maximum. A more sophisticated method for end of page detection is required to overcome this situation. Also it must ensure the suppression of control group headings near the bottom of a page when there will not be enough room for at least one detail line to follow. These features are taken in to account in the design of the more elaborate COBOL report program generating system described in Chapters 6 and 7.

3.7.3 The influence of the problem specifying language

The use of the pre-defined Filetab language to specify the problem to the macro processor, so that it, in turn, could generate a COBOL program to provide a solution, proved valuable. It not only established the feasibility of the approach, but also served to highlight areas where it was more difficult to

translate the problem language into COBOL statements. For example, one such difficulty was caused by the fact that both Filetab and the macro processor used the single quotation mark character (') to delimit a text literal. Special processing, as outlined in Section 3.6.2, was needed to overcome the problem. Thus, in the design of any problem specifying dialogue for use with this macro processor, the choice of a different text literal would be advisable. As the dialect of COBOL being generated by the system uses the double quotation mark character (") to delimit alphanumeric literals, it would be appropriate to adopt the same character, for the same purpose, in the design of a problem specifying dialogue.

The Filetab *FILE directive has no parameter which describes the maximum record length of the file, hence the adoption of 2048 characters as the record size by the COBOL generating macros (3.5). If this piece of data could be supplied in a computer/user dialogue, the generated program would require less core storage and have fewer FILLER statements when the file's record length was less than the 2048 assumed at present.

The experience gained from Filetab to COBOL program translation will influence two other aspects in the design of a computer/user dialogue for the generation of a COBOL program.

The first is related to the design of the format of report lines. The parameter records for the *TITLE, *HEAD and *OUT Filetab directives provide a simple straight forward way of specifying the layout of an output line, but it was felt that the use of a visible character to denote blank characters between fields would be an advantage. This is especially so if the report layout is to be designed by the user whilst sitting at a terminal, rather than pre-planned using squared paper. It is far more

difficult to count the number of blank spaces between fields than it is to count the number of characters in a field.

Secondly, in the design of a problem specifying system for the generation of COBOL programs using the PG/1 macro processor, the numeric designation of control levels would be advantageous (3.7.4).

3.7.4 PG/1 Macro processor limitations

The main deficiencies in the PG/1 macro processor which were highlighted during the Filetab to COBOL generation study were as follows:

1. No facilty for ordering alphabetic characters.
2. No subscripted variables.

In addition a number of desirable enhancements to the PG/1 macro processor facilities were identified, these included:

1. The provision of an overlay mechanism.
2. Provision of macro-time facilities for subfile input/output.
3. Provision of extraction facilities for long strings.

The PG/1 macro processor deficiencies became particularly apparent during the development of the macro-time statements for generating the COBOL paragraphs associated with control break processing (Appendix III Section 8). The Filetab alphabetic control characters could be compared only in an equal/not equal situation, and the lack of subscripting facilities prevented the use of table look-up as a means of ordering them. This resulted in the use of a large number of macro-time IF statements during the processing to determine the next control level in the Filetab job hierachy.

The Filetab to COBOL translation study also served to highlight areas where enhancements to the macro processor

facilities would enable COBOL programs to be generated more effectively. The large number of macro-time statements required to process the various Filetab directive and parameter records strained the macro processor's internal areas for tables and stacks to the utmost (Appendix I Section 1). A significant increase in the core storage requirements would not ease the situation as, in many computer installations, the macro processor would be relegated from on-line mode to background batch mode. This points the need for some form of overlay facility.

A great weakness of the Filetab to COBOL system is the need to subdivide it into three phases, generating, filing and synthesising. This coud be overcome if new macro-time statements to exploit the existence of the macro subfiles were designed and implemented. The ability to read, insert and delete specific subfile records from within a macro definition would prove a powerful tool. So too would be the implementation of macro-time statements to enable the output stack, containing the generated statements, to be emptied and the contents filed in a specific subfile.

The macro processor has facilities for the extraction of character strings from the input buffer, namely the macro-time statements CALLFSTR and CALLVSTR. These are, however, limited to eight characters, the maximum number which can be stored in a local or global variable. This meant that the text information from the parameter records of the *TITLE and *HEAD directives had to be extracted piecemeal (Appendix III Sections 5 and 6). This points the need for the design and implementation of improved macro processor facilities for handling character strings.

3.8 SUMMARY, APPRAISAL AND CONCLUSIONS

To an extent some of the difficulties outlined in the preceding sections are due to the structure and form of the macro processor used for this project and the nature of the COBOL language. However, the problem probably admits no really simple solution because of the complexity of the interlacing of the program order and the generating order of the COBOL statements, the very variable size of the items generated and the volume of the code to be generated. It would, of course, probably be possible to design a special purpose translator to carry out the translation efficiently for the particular language chosen for the project. The volume of code generated when producing COBOL programs necessitates the use of backing stores rather than main storage. This being so, the existing macro processor at least offers the advantage of a close integration between macro facilities, file handling facilities and system commands which control the operation of the system.

The work described in this chapter represents part of the feasibility study for this part of the project, since once the overall structure is defined it is relatively easy to fill in all the details (Appendix III).

The processor designed as the result of these investigations is a valuable outcome of the project in the sense that a system for 'growing programs' and synthesising general program structures is applicable to any target language.

The method used for the generation of COBOL programs using the PG/1 macro processor is in marked contrast with that used in the generation of FORTRAN programs [5]. In FORTRAN the volume of code generated for each routine was significantly less and, because it is a relatively unstructured language, the ordering of

generated statements did not present undue problems. Only very small sections of original FORTRAN code were generated in the main program, otherwise extensive use of pre-prepared subroutines was made. These subroutines were specially parametised using the macro facilities so that they could be used to generate a wide variety of different subroutines for use in different situations.

The most important conclusion which may be drawn from the Filetab to COBOL generation study is that, from the experience gained and with some modifications to the macro processor, this approach can be used to create a system for translating a problem specified in a non-procedural language into a program specified in a procedural language. Secondary conclusions are that the generated COBOL is of reasonable quality and that a COBOL program is much more difficult to generate than a FORTRAN program (c.f. [5]).

CHAPTER 4

ENHANCEMENTS FOR THE PG/1 MACRO PROCESSOR

4.1 INTRODUCTION

The results reported in Section 3.7, as a result of experience with developing a Filetab to COBOL program generator, highlighted areas where enhancements to the PG/1 macro processor would enable COBOL programs to be generated more effectively. In order to specify a processor adequate to permit the completion of the planned project the following main areas were identified for improvement:

1. The introduction of an overlay facility to reduce the core storage demands of the macro processor, and thus make adequate space available for the macro processor's internal stacks and tables.

2. The provision of macro-time statements to permit the reading, writing, insertion and deletion of records in the macro processor's disc based subfiling system.

3. The implementation of macro-time statements which allow the PG/1 macro processor's output stack, containing generated statements, to be emptied when desired and the contents printed or filed in a specified subfile.

4. The extension of the macro processor facilities for character manipulation.

The desirability of improving the PG/1 macro processor facilities in the areas mentioned above was reinforced when the practical considerations for the design and implementation of the computer dialogue, proposed in Chapter 5, were taken into account.

The following paragraphs of this chapter specify in greater detail the facilities which would extend the scope of applications for the PG/1 macro processor. The subsequent implementation of

most of the proposals led to the development of the PG/2 macro processor. The formal specification of the enhancements proposed for the PG/2 macro processor are given in Appendix IV. (The implementation of the enhancements did not form part of the candidate's work on this project.) Section 4.8 gives an assessment of the PG/2 macro processor and the chapter concludes with a summary.

4.2 REDUCTION OF CORE STORAGE DEMANDS

The validation of input in the Filetab to COBOL generation study described in Chapter 3 was minimal. In contrast, extensive validation of the user's responses to the computer dominated dialogue described in Chapter 5 is required, before the information they contain can be used to generate COBOL statements. This is particularly true of the user's specifications for the selection of data, report layout design and own code processing. Extensive validation of responses is also required in the dialogue with the Data base Administrator, during the setting up and maintenance of the Catalogue of File descriptions (5.2 and 6.3). The macro-time statements for input validation and for the output of diagnostic messages when errors occur is very demanding in terms of storage requirements. Fortunately, the Catalogue maintenance and problem specifying dialogues of the COBOL generating system can each be divided into relatively independent stages. This is comparable with the way in which each Filetab directive was independently processed in the project described in Chapter 3. The development of a macro overlay facility was therefore a practical proposition from the COBOL generation point of view.

The request to the person maintaining the macro processor for the provision of an overlay facility led to the formulation of

the CHAIN feature (Appendix IV Section 1.6). When used in a macro definition it causes, during the second pass of the macro (Appendix I Section 2), the contents of one or more macro definitions to be loaded into core and for one of the macros to be called. The newly loaded macro definitions replace those previously in core. A control parameter allows the user to specify whether or not string variables and/or global variables are to be initialised in addition to the reinitialisation of the macro processor stacks.

The following annotated example illustrates the use of the CHAIN feature:

```
%FILE,0,FILE2ß
%DEF   STAGE2
       ¦
       ¦
       ¦
%END
%DEF   STAGE3
       ¦
       ¦
       ¦
%END
%%%%%%%%%
%DEF   STAGE1
       ¦
       ¦
       [CHAINO,FILE2]
       [STAGE2]
%END
%      STAGE1
```

File statements for macro definitions STAGE2 and STAGE3 in subfile FILE2.

Define and execute the STAGE1 macro.

During the second pass in the execution of STAGE1, the CHAIN statement and the one following cause the contents of subfile FILE2 to be loaded into core and macro STAGE2 to be called. Macros STAGE2 and STAGE3 replace STAGE1 in core. The zero value for the control parameter indicates that global and string variables are to remain unchanged, but that the macro processor stacks are to be reinitialised.

The CHAIN facility is extensively used during problem specification in the COBOL generating system (7.1).

4.3 REDUCTION IN THE USE OF LABELS

As macro definitions become larger and more complicated the number of statement labels used becomes greater, but the label table of the macro processor has only a limited capacity. The larger macro definitions tend to make more use of the routine facility provided by the OBEY and RETURN macro-time statements. The OBEY statement specifies the label of the first statement in the routine to be obeyed and also the label of the statement to which the return should be made. Frequently the return statement is that immediately following the OBEY statement. When this situation occurs this pair of instructions is extravagent in the use of labels. Some ecconomy in the use of the label table can, in such cases, be effected by the provision of two new macro-time statements for calling routines, viz CALL and EXIT (Appendix IV Sections 1.1 and 1.10).

The CALL statement requires that only the label of the first statement of the routine to be executed should be specified. The EXIT statement ensures that the called routine returns control to the statement following the CALL statement. The examples which follow illustrate the differences in the use of these pairs of statements and show the savings made in the use of statement labels.

```
%DEF  MACROA
      |
      |
%     OBEY 200,101
%101  -----
      |
      |
%     OBEY 200,102
%102  ----
      |
      |
      |
      |
%200  ------
      |
      |
      |
%     RETURN
      |
      |
      |
%END
```

PG/1 macro processor

```
%DEF  MACROB
      |
      |
%     CALL 200
      |
      |
%     CALL 200
      |
      |
      |
      |
%200  -----
      |
      |
      |
%     EXIT
      |
      |
      |
%END
```

PG/2 macro processor

The CALL and EXIT macro-time statements are used extensively to control the execution of routines in the macros of the COBOL generating system, e.g routines PROMPT, SEARCH etc (Appendix VI).

4.4 ACCESS TO SUBFILES

The PG/1 macro processor only permits access to the disc based subfiling system by means of System commands, e.g. %LOAD, %FILE etc, which may not be used within a macro definition. This necessitated the use of three phases, viz Generation, Filing and Synthesis, in the Filetab to COBOL generation study (3.3.4). In order to avoid a similar inelegant state of affairs in the self tutorial COBOL program generator, the provision of subfile handling macro-time statements was of prime importance. This requirement was emphasised by both the need to store and access the large volume of instructional text and the need to extract

information from the Catalogue of File descriptions. To meet these requirements five new macro-time statements were implemented to enable specific subfile records to be accessed and manipulated:

SELECT (Appendix IV Section 1.19)

FREAD (Appendix IV Section 1.11)

REPLACE (Appendix IV Section 1.17)

INSERT (Appendix IV Section 1.14)

DELETE (Appendix IV Section 1.8)

The SELECT statement designates the subfile to which subsequent record handling macro-time statements refer. The named subfile remains selected until superceded by that given in the next SELECT statement executed.

In the other four macro-time statements the required record is referenced by its sequence number within the subfile. The FREAD, REPLACE and INSERT statements permit, respectively, the reading, replacement and insertion of a record. In the first instruction a designated string variable is used to receive the data from the subfile record, while in the two latter instructions the string variable is used as the source of the replaced or inserted data. The DELETE statement requires that only the number of the record to be deleted should be specified.

The following annotated macro outline illustrates these new macro-time statements in use:

```
%DEF  FILECHANGE
%     SELECT DICTIONARY          Select the DICTIONARY subfile
                                 for amendment.

%     DELETE 2                   Delete the second record.

%     FREAD 8,#$02               Read the data from the 8th
                                 record into string variable
                                 #$02.

%     REPLACE 8,#$03             Replace the 8th record by the
                                 data in string variable #$03.

%     INSERT #LV1,#$01           Insert a new record containing
                                 the data in string variable
                                 #$01 before the record whose
                                 number is contained in local
                                 variable #LV1.

%END
```

The Catalogue maintenance macros (6.3) make extensive use of these new macro-time statements.

4.5 EMPTYING THE OUTPUT STACK

COBOL is a verbose language and even a request for a simple report requires the generation of a fair number of COBOL statements. Not only is the macro processor's output stack of limited capacity, but the generated COBOL statements are destined for different macro definition subfiles (7.3.4). In the PG/1 macro processor the system macro %SAVE is the only means of emptying the output stack and directing the disposal of its contents, but it cannot be used from <u>within</u> a macro definition. The interspersion of %SAVE commands between calls to macro definitions was rejected in the Filetab to COBOL study (3.3). With the provision of the CHAIN facility in the PG/2 macro

processor, which facilitates the automatic loading and calling of macro definitions, the use of %SAVE is not, in any case, possible until the end of the macro chain has been reached. In order to avoid both the overflow of the output stack and the need to have three phases, as in the Filetab to COBOL generation study, additional stack emptying facilities are required.

In order to satisfy the above requirements two new macro-time statements, PRINT and SAVE, were formulated (Appendix IV Sections 1.16 and 1.18). The proposed statements have a syntax and semantics which are consistent with other facilities currently provided by the PG/1 macro processor.

The PRINT statement causes the output stack to be emptied and the contents printed on the user's terminal if the macro processor is being used in on-line mode. If batch mode is used the stack contents is directed to the line printer.

The SAVE macro-time statement causes the output stack to be emptied and the contents directed to the specified subfile. A control parameter is used to indicate if the data is to be stored at the beginning of the subfile or appended after the existing records.

The following outline example illustrates the use of these new macro-time statements:

```
%DEF   STAGE5
       |
       |                          Generate statements in the output
       |                          stack.
       |
%      SAVE,0,OUTREC              Empty the output stack and direct
       |                          its contents to the beginning of
       |                          the OUTREC subfile.
       |
       |
       |                          Generate statements in the output
       |                          stack.
       |
%      SAVE,0,WRITEREC            Empty the output stack and direct
       |                          its contents to the beginning of
       |                          the WRITEREC subfile.
       |
       |
       |                          Generate statements in the output
       |                          stack.
       |
%      SAVE,1,OUTREC              Empty the output stack and append
       |                          its contents to the OUTREC subfile.
       |
       |
       |                          Generate statements in the output
       |                          stack.
       |
%      PRINT                      Empty the output stack and print
       |                          the contents.
       |
       |
%END
```

The implementation of these macro-time statements is discussed again in Section 4.8.

4.6 STRING HANDLING FACILITIES

4.6.1 String extraction

The proposals for the self tutorial COBOL generation system involve a considerable amount of character manipulation, both in the validation of user's responses and the extraction of relevant information for inclusion in the generated COBOL statements. The PG/1 macro processor's string extraction statements, CALLFSTR and CALLVSTR, permit the extraction of fixed and variable length character strings respectively. As the characters are extracted into local or global variables, eight is the maximum number of characters which may be extracted at one time. In the Filetab to COBOL generation study this restriction led to repetitive coding. For example, to extract the first 48 characters from the input buffer and use them in the generation of a COBOL statement to define the value of an alphanumeric literal, six uses of CALLFSTR are needed to place the 48 characters in six <u>different</u> variables.

To alleviate the above situation the PG/2 macro processor provides two new macro-time statements for extracting fixed and variable length strings, viz FSTR and VSTR (Appendix IV Sections 1.12 and 1.23). They are powerful instructions for not only do they permit the extraction of up to 72 characters into a string variable, but the source may be any string variable or the input buffer. The above mentioned problem may now be solved more concisely by using a string variable, say #S01, to store the extracted characters:

```
%     FSTR1  ,1,48
```

The absence of the second parameter in the FSTR statement indicates that the characters are extracted from the input buffer. If the the required characters had to be extracted from string

variable #S02, then the above example would have been written as follows:

```
%     FSTR1 #S02,1,48
```

The variable length string instruction, VSTR, is similar in form to FSTR except that the final parameter is the marker which, when encountered in the source data, terminates the operation.

4.6.2 Comparison operators

The PG/1 macro processor restricts to four the IF statement operators available for use with string operands, namely IN, AT, EQ and NE (Appendix I Section 5). In the PG/2 macro processor these are supplemented by four more operators (Appendix IV Section 1.13):

LE (less than or equal to)

LT (less than)

GE (greater than or equal to)

GT (greater than)

Together with the enhanced string extraction facilities, the new IF statement operators provide users of the PG/2 macro processor with powerful instructions for validating and ordering character string data.

4.6.3 Removing spaces from String valued variables

The PG/1 macro processor provides the SQUASH macro-time statement for the removal of spaces from string data in the input buffer. When the string data from which it is desired to remove spaces is in either a local or global variable six statements are required to achieve the desired effect:

```
%       RESET #SO1
%       DEPOSIT1 #LV1          Load input buffer with the
%       READ #SO1              contents of #LV1.

%       SQUASH                 Remove spaces.

%       #GOUP=#GSTC            Restore the squashed data
%       CALLFSTR(#LV1,1,0)     to #LV1
```

The PG/2 macro processor does away with this inefficiency by means of a new macro-time statement, CALL SQUA (Appendix IV Section 1.4). This statement enables the above six statements to be replaced by the following statement:

```
%       CALL SQUA #LV1
```

4.6.4 Concatenating String valued variables

The concatenation of character data in a string variable is effected in the PG/1 macro processor by means of the DEPOSIT statement. For example, to concatenate the contents of local variable #LV2 and string variable #SO1 the following statement is used:

```
%       DEPOSIT1 #LV2#SO2$
```

If the concatenated data results in a short string of eight or less characters, it is uneconomic to use a string variable when a local or global variable would suffice. To cover this eventuality the PG/2 macro processor introduces the CALL DPOS macro-time statement (Appendix IV Section 1.2). This enables either text or the string contents of a local or global variable to be concatenated with the characters in another local or global variable. The result is always truncated if it exceeds eight characters, the maximum possible in such a variable. For example, to concatenate the contents of local variable #LV1 with that of global variable #GV2 we write:

```
%       CALL DPOS #GV2,#LV1
```

If #GV2 and #LV1 initially contained 'ABCDEF' and 'GHIJKL' respectively, the resulting contents of #GV2 would be 'ABCDEFGH'.

4.6.5 Interchanging characters

When manipulating a character string it is sometimes desirable to interchange characters. In order to meet this need the PG/2 macro processor provides two new macro-time statements, CALL SWAP and SWAP (Appendix IV Sections 1.5 and 1.21). The former is applicable to character strings in local and global variables, while the latter applies to the contents of string variables. Each statement requires three arguments:

1. The variable name or string variable number.
2. The character to be replaced.
3. The replacing character.

Single or multiple occurrences of the second argument character are replaced by a single occurrence of the third argument character. The SWAP statement can also be applied to the contents of either the input or output buffer. In the former case the first parameter is omitted, while in the latter case it is given the value zero.

If, given the string 'ABBCDBEF', it is desired to replace 'B' by 'G' so that the string becomes 'AGCDGEF', then one of the following macro-time statements can be used to achieve the desired result. The first statement is applicable if the given character string is in a local variable called #LV1, while the second statement is used if the given string is in string variable #S01.

```
%     CALL SWAP #LV1, B, G
%     SWAP1, B, G
```

4.6.6 Extension of SQUASH and DEPOSIT

The SQUASH statement of the PG/1 macro processor enables spaces in the input buffer to be removed. In the PG/2 macro processor this facility is extended so that spaces can be removed from any designated string variable. The new form of the statement is:

% SQUASHn

where n denotes the number of the string variable from which spaces are to be removed (Appendix IV Section 1.20). If n is omitted then the operation applies to the input buffer as in the PG/1 version. If n is zero then the output buffer will be operated on. Global variable #GSTC is still used by the new macro-time statement to store the character count of the resultant string.

The PG/1 macro processor statement

% DEPOSITn ⟨choice⟩%

copies the chosen character string(s) into the designated string variable #Sn, starting at the first available 'unfilled' character position. If n is zero the output buffer is used as the receiving string. The PG/2 macro processor extends this copying facility to include the input buffer as a receiving string (Appendix IV Section 1.9). This is achieved by omitting a value for n in the DEPOSIT statement.

4.6.7 Length of variables and strings

In the PG/1 macro processor the length of a variable or a string can only be determined by placing it in the input buffer, executing a SQUASH statement and interrogating the value in global variable #GSTC. Besides requiring several operations, this

method is not useful if the string whose length is required contains imbedded spaces, as they are not included in the character count. To overcome these deficiencies the PG/2 macro processor provides a new macro-time statement CALL LENV (Appendix IV Section 1.3). The name of the variable or string whose length it is desired to know is supplied as a statement parameter, e.g.

```
%     CALL LENV #LV1
%     CALL LENV #SO3
```

Global variable #GSTC is set to the length of the given variable or string.

4.6.8 Copy arguments into strings

The PG/1 macro argument facility allows numeric arguments to be assigned to either local or global variables, as shown in the following example, where the / character is used to denote the argument marker:

```
%DEF  EXAMPLE1(/,/)
%     #LV1=/1:1/
%     #LV2=/1:2/
%     #LV3=/1:3/
      :
      :
%END
%     EXAMPLE(5,4,8)
```

After the execution of the above macro call, local variables #LV1, #LV2 and #LV3 will contain the values 5, 4 and 8 respectively. It is not however possible to copy character string arguments into string variables, because the DEPOSIT macro-time statement does not include macro arguments among the possible choices. This restriction is removed in the PG/2 macro processor (Appendix IV Section 1.9), where it is possible to write statements of the type shown in the following example:

```
%DEF   EXAMPLE2(/,/)
%      #LV1=/1:1/
%      #LV2=/1:3/
%      RESET #SO1
%      DEPOSIT1 /1:2/$
       ¦
       ¦
%END
%      EXAMPLE2(5,PART-NUMBER,8)
```

After the execution of the above macro call, local variables #LV1 and #LV2 will contain the values 5 and 8 respectively. String variable #SO1 will contain the character string 'PART-NUMBER'.

4.7 OTHER FACILITIES

During the preliminary investigations associated with the design of the self-tutorial COBOL generating system, three other desirable macro processor facilities were identified:

1. The provision of reserved global variables containing the current date and time and macro-time statements which enable their contents to be updated as required.

2. The extension of the arithmetic operation facilities to include multiply and divide operators.

3. To increase the number of subfiles in the PG/1 macro processor's disc based filing system, which is currently limited to a maximum of 30 subfiles.

4.7.1 Date and Time

As the Catalogue subfile (6.3) is updated 'in place', it is essential for security purposes to make 'back up' copies at regular intervals. Recovery procedures can, in the event of a failure, be carried out more readily if the date and time of creation of the subfile are known. To meet this need the PG/2 macro processor provides two new macro-time statements, DATE and TIME (Appendix IV Sections 1.7 and 1.22). These cause the current

date and time in character form to be stored in new global variables #GCDT and #GCTM respectively. When used in a macro definition, the DATE and TIME statements will cause #GCDT and #GCTM each to contain eight characters in the form DD/MM/YY (i.e. day, month, year) and HH/MM/SS (i.e. hours, minutes, seconds) respectively.

Each time the CATALOGUE subfile is updated, the contents of these global variables is included in the first record of the subfile. Their contents are also printed out for the Data base Administrator's information (Section 6.3).

4.7.2 Extended Arithmetic

The need for multiply and divide operators was highlighted by:

1. The calculations required to maintain the record counts in the CATALOGUE subfile.

2. The calculations to establish the current record number during the binary search of a subfile (Appendix VI Section 2).

3. The calculations associated with line counts in the preparations for showing the user a sample report page (7.25).

These are provided in the PG/2 macro processor, which uses the conventional computer language symbols * and / to denote the multiply and divide operators respectively (Appendix IV Section 5). The order in which the arithmetic operations in an expression are carried out is strictly from left to right. Thus after the evaluation of the following statement, #LV1 will contain the value 7.

```
%     #LV1=2+8/3*4-5
```

4.7.3 Main file facility

The COBOL report program generating system (Section 7.2) requires the use of a large number of subfiles for the storage of macro definitions, common data, dialogue text, etc. However, the design of the PG/1 macro processor allows a maximum of 30 subfiles in the subfile directory when its disc file is initialised. In order to overcome this limitation without having to completely restructure the subfiling system, the PG/2 macro processor has a facility which permits the use of any number of disc files, each containing a maximum of 30 subfiles.

The MAINFILE facility, implemented in the PG/2 macro processor in the form of a system macro (Appendix IV Section 3) and a macro-time statement (Appendix IV Section 1.15), allows the user to change the name of the currently referenced disc file at will.

Thus to change the name of the main file to FIRSTMASTER before loading and calling a macro definition, the user would use the system macro:

%MAINFILE,FIRSTMASTER%

Within a macro definition, a user wishing to change the name of the currently selected mainfile to SECONDMASTER would use the following macro-time statement:

```
%     MAINFILE,SECONDMASTER
```

4.8 ASSESSMENT OF THE PG/2 MACRO PROCESSOR

In the development of the macro processor from MP/1 through PG/1 to PG/2, the power of the processor has been increased. What was designed as a language preprocessor (to extend an existing procedural language) has been extended in an ad hoc way to:

1. Translate dialogue into FORTRAN.

2. Translate dialogue into COBOL.

The system, whose strengths lie in its string handling and expansion-time facilities, is clearly general purpose and reasonably flexible.

The weaknesses of the macro processor arise from its relatively low level language with ill defined syntax and poor diagnostics - the latter are a result of its history. As far as the present project is concerned the main weaknesses lie in the missing features identified below:

1. Subscripted variables.

2. Subroutines with names and parameters.

3. Separately compiled segments (CHAIN provides this in part).

The majority of the PG/2 macro processor enhancements described in Appendix IV were successfully and efficiently implemented, but the two following features require further consideration:

1. The facility to empty the output stack from within a macro definition.

2. The reading, replacement, insertion and deletion of subfile records.

4.8.1 Emptying the Output Stack

The proposals for emptying the macro processor output stack from within the body of a macro by two new macro-time statements, PRINT and SAVE, proved difficult to implement. The structure of the PG/1 macro processor is such that material is only transferred to the output stack when the %END statement which terminates the macro body is encountered. In order to implement the proposed

SAVE and PRINT macro-time statements, considerable restructuring of the macro processor was found to be necessary. The manpower and financial resources were not available to undertake this major reorganisation in the PG/2 version of the macro processor used for the practical work of this project.

4.8.2 Access to subfile records

Five macro-time statements, SELECT, FREAD, REPLACE, INSERT and DELETE, were implemented to provide facilities for accessing and amending the contents of subfiles within the PG/2 macro processor filing system.

Ideally these macro-time statements should be applied to subfiles with direct access or indexed sequential organisation. The subfiles within the PG/1 macro processor filing system are, however, sequentially organised. In order to avoid major changes to the subfiling system, the implementation of these macro-time statements in the PG/2 version of the macro processor was perforce inefficient.

To read the nth record of a subfile using the FREAD macro-time statement the following processing is required:

1. Open the subfile specified by the previous SELECT macro-time statement.
2. Read n records.
3. Return the nth record to the user.
4. Close the specified subfile.

The implementation of the REPLACE, INSERT and DELETE macro-time statements relies on the fact that a subfile can be read and written at the same time, providing that the operations do not refer to the same bucket. By provision of an internal buffer

large enough to hold the contents of 1 bucket (128 words) plus a little work space, this situation is avoided. Also the macro processor filing system has two 128-word buffers of its own, one for read and one for write. The macro-time statements for amending the contents of the nth subfile record requires the following processing:

1. Open the subfile specified by the previous SELECT macro-time statement.

2. Read and write all records up to the nth record.

3. Replace, delete or insert the nth record as required.

4. Read and write the rest of the subfile records until the end of the file is reached.

5. Close the specified subfile.

For subfiles containing 5 or 6 records this method of implementing access to records is acceptable. However, for larger subfiles, especially the Catalogue of File descriptions and those containing the instructional text, the delays are unacceptable. For example, the instructional text for the first stage of the problem specifying dialogue occupies 44 records in the DIAL1 subfile. The processing in the STAGE1 macro (7.8) consists mainly of reading the DIAL1 subfile records and outputting their contents on the user's terminal. During the execution of the STAGE1 macro the output of these 44 lines of text on a 10 characters per second teletype took approximately 11 minutes. The interval between the output of lines lengthened noticeably towards the end of the subfile. An output time of 5 minutes would have been more acceptable, as this would have kept the teletype almost continuously in operation.

It is appreciated that the terminal response times and access to disc files in a multiuser operating system are dependent

on the resource demands of other users, and that not all the printing delays can be attributed to the inefficient implementation of the macro-time statements. Nevertheless, the latter are significant enough to reduce the effectiveness of the COBOL report program generating system based on the existing PG/2 processor.

4.9 SUMMARY, APPRAISAL AND CONCLUSIONS

The macro processor enhancements specified for the PG/2 version (Appendix IV) provide only the basic facilities required for the generation of COBOL programs. The structure of the macro processor is such that, within the resources that were available, not all the enhancements could be provided and some could only be implemented inefficiently.

The lack of some desirable features and the inefficient implementation of others tended to prolong the time taken over the practical development of COBOL generating macros. The lack of the basic stack emptying facility precludes the complete development of the proposed system beyond the fourth stage (6.2.2).

The conclusion is that, although not an ideal tool for the generation of COBOL programs, the PG/2 macro processor serves to identify the characteristics of an appropriate tool (Appendix XI).

CHAPTER 5

THE USER INTERFACE

5.1 INTRODUCTION

In this chapter the interface between the casual computer user and the COBOL report program generating system is discussed. The material presented covers the following topics:

1. The need to present the casual user with a simple view of his data which does not depend on a knowledge of its physical organisation.

2. The adoption of the relational approach so that the user may view his data in the familiar tabular form.

3. Desirable features which should be incorporated into a dialogue designed for the casual user.

4. Aspects of the problem specifying dialogue which require more complicated user responses - conditions for data retrieval, report layout design and own code processing.

5. The gathering of users' comments on the system as an aid to improving the system.

6. The description of a model problem, the dialogue for which is available for viewing as part of the 'help' facility.

The chapter is supported by Appendix IX (which contains the dialogue for the model problem) and concludes with a summary and appraisal.

5.2 USER'S VIEW OF THE DATA

In order to generate a COBOL program the details of the physical and logical organisation of the data files to be used by it must be supplied to the program generating system. This section discusses how this can be done without burdening the casual user with the need to supply technical information and, at

the same time, allow him to take a 'simple' view of the data.

In common with report generators all COBOL programs require details of the form and organisation of the external data on which they are to execute. In the Filetab report generator the user supplies these details in the *FILE and *INL directives (Appendix II Sections 3.1 and 3.2). In a COBOL program similar information has to be specified in the Environment and Data divisions. The information required includes file medium, hardware assignment, recording mode, file labels, block and/or record length, data record names, record structure, descriptions of fields within records, etc.

Despite the fact that many of the above COBOL data specifications have default values, as do those for Filetab, it is unreasonable to expect a non-programmer to understand the physical organisation and storage of the data available for use, nor to be able to supply even the essential details to any system which generates COBOL programs. Not only will a non-programmer not understand the physical organisation of a file, but he will have difficulty in the concept of a record and with the organisation of data into records and records into files. It is clear, therefore, that some attempt to divorce the logical view of the user's data from its physical organisation and storage must be made, if a COBOL program generator, for use by a non-programmer, is to be an effective and useful tool.

The separation of the physical organisation of data from its logical organisation is one of the things which is achieved by a Data base system. A Data base is defined by Martin [7] as:

' A collection of interrelated data stored together with controlled redundancy to serve one or more applications; the data are stored so that they are independent of programs which use the data; a common and controlled approach is used in adding new data

and in modifying and retrieving existing data within the data base. A system is said to contain a collection of data bases if they are disjoint in structure.'

Different users have different views of the data within the same data base. This is dictated partly by the security restrictions which may be applied to sensitive data. Thus each data base user is provided by the Data base Management System with the following:

1. His requirements for access to data defined as a submodel, which is just part of the complete data model of the data base.

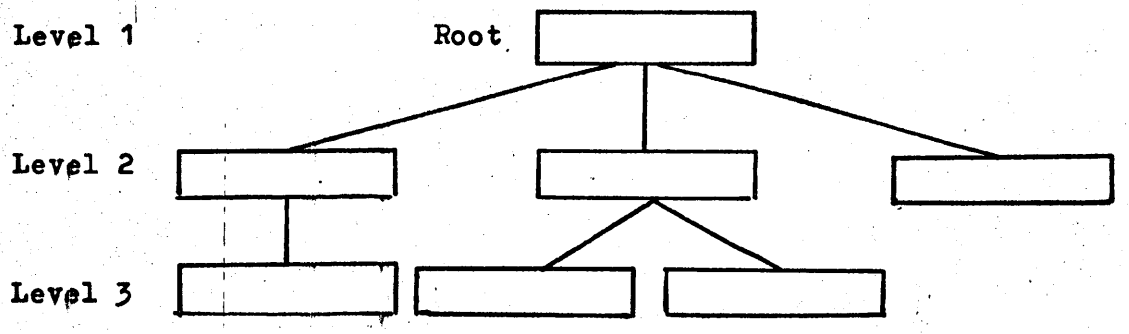
2. A language with which to specify his requirements for processing the data.

The data base user is concerned only with the logical organisation of that portion of the data available for his use, while the physical organisation of that data and of the complete data base is the responsibility of a Data base Administrator. The responsibilities of a Data base Administrator range much wider than decisions on the storage structure and access strategy of the data in the data base. Other responsibilities will include deciding on the information content of the data base, maintaining a data dictionary (defining the data, its source, uses, ownership, etc.), liasing with users, defining security checks and validation procedures, ensuring that a strategy for back up and recovery exists in event of computer failure, monitoring the performance of the data base system and responding to requirement changes.

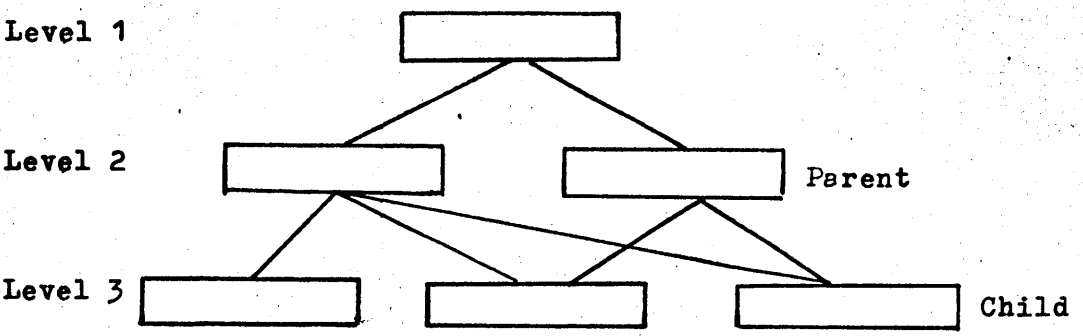
Data base systems are generally classified into three major categories:

1. Hierachical.
2. Network.
3. Relational.

In a Hierachical data base a file contains records some of which are subordinate to others in a tree structure. The highest level record in the hierachy is called a 'root'. All records except the 'root' are related to only one record in the tree structure and that is on a higher level than themselves, e.g.



In a Network data base system a relationship between records exists such that a 'child' record can have more than one 'parent' record, e.g.



A Network structure can, however, be represented as a hierachical tree structure or structures but with redundant elements.

In contrast with the Hierachical and Network data base systems, a Relational data base gives the user a simpler view of his data. He sees it as a table and a set of relations between tables rather than as a linked record structure. This is particulary valuable as the tabular view of the data is familiar to even a non-programmer. The tabular view of a Relational data base is discussed further in Section 5.3.

Four main conclusions applicable to a COBOL generating system for use by non-programmers may be drawn from a preliminary

study of data base systems:

1. The user should not be aware of the physical organisation of the storage of the data files.

2. Access to sensitive data should be protected by some security mechanisms.

3. Only data relevant to the solution of the current problem should be described in the generated COBOL program.

4. The user's view of the data should be kept as simple as possible by adopting a relational view, and he should only be aware of the organisation of the data relevant to his application.

The above requires the setting up and maintenance of a catalogue of data file descriptions, to which the COBOL generating system can gain access by means of security passwords. Further discussion of this aspect follows in Chapter 6.

5.3 RELATIONAL APPROACH

This section shows how the 'flat' files used by a COBOL program lend themselves to a relational data base approach. Thus the user may take a tabular view of his data when describing his request for a report program to the COBOL generating system.

The relational approach is based on the mathematical theory of relations. Date [10] quotes the following definition of a Relation:

'Given sets D_1, D_2, ..., D_n (not necessarily distinct), R is a relation on these n sets if it is a set of ordered n-tuples $\langle d_1, d_2, \ldots, d_n \rangle$ such that d_1 belongs to D_1, d_2 belongs to D_2, ..., d_n belongs to D_n. Sets D_1, D_2, ..., D_n are called the "domains" of R. - The value of n is called the "degree" of R.'

The entanglements that build up in complex hierarchical or network structures can be avoided in the relational data base by

Figure 5.1 STAFF Relation

DEPT-NO Major key	EMPLOYEE-NO Minor key	EMPLOYEE-NAME
01	2056	BROWN C.W.
01	5021	JONES B.
01	8028	SMITH L.
02	1019	ADAMS M.
02	2022	BLACK J.
02	3027	FINLAY A.
02	4045	GREEN I.N.
02	6007	NEAL S.
03	7054	PORTER M.B.
03	8034	SMITH P.J.

Tuples

Figure 5.2 PERSONNEL Relation

EMPLOYEE-NO Key	SEX	AGE
1019	F	20
2022	M	56
2056	M	30
3027	M	60
4045	M	38
5021	F	19
6007	M	23
7054	F	20
8028	F	42
8034	M	

Tuples

Figure 5.3 Join of STAFF and PERSONNEL Relations

DEPT-NO Major key	EMPLOYEE-NO Minor key	EMPLOYEE-NAME	SEX	AGE
01	2056	BROWN C.W.	M	30
01	5021	JONES B.	F	19
01	8028	SMITH L.	F	42
02	1019	ADAMS M.	F	20
02	2022	BLACK J.	M	56
02	3027	FINLAY A.	M	60
02	4045	GREEN I.N.	M	38
02	6007	NEAL S.	M	23
03	7054	PORTER M.B.	F	20
03	8034	SMITH P.J.	M	29

Tuples

the technique of 'normalisation', which was originally designed and advocated by Codd [11]. Although Codd's principles relate to the logical or user's view of the data and do not apply to its physical representation, it is fortuitous that many COBOL programs use physically 'flat' files which lend themselves to the relational approach. Thus the flat file may be regarded as a relation and the fields within the records of the file are regarded as domains.

The user of a Relational data base need not, however, be concerned with the three-level concept of normalisation as propounded by Codd. It is only necessary to present the user with the familiar two-dimensional concept of a table of data. Thus a relation is represented by a table in which the entries for a column are items from the same domain. The rows of the table, referred to as tuples, contain a set of data items relating to one entity, i.e. attributes. In order that each tuple can be uniquely identified it must have at least one key; that is, at least one attribute of a tuple must be designated as a key to ensure the tuple's unique identity.

Figure 5.1 illustrates the user's view of a relation called STAFF, which is defined over the domains DEPT-NO (department number), EMPLOYEE-NO (employee number) and EMPLOYEE-NAME (employee name). It requires two keys DEPT-NO and EMPLOYEE-NO to identify a unique tuple. Similarly, Figure 5.2 illustrates the user's view of a relation called PERSONNEL, which is defined over the domains EMPLOYEE-NO, SEX and AGE. The PERSONNEL relation has EMPLOYEE-NO as a key domain. As the STAFF and PERSONNEL relations have a common key domain, they can be joined to present the user with the view of the data shown in Figure 5.3.

A 'query language' is essentially the means by which the user specifies what he wants to do with the data, i.e. extract

information from the data base. For a relational data base the query language may be founded on either relational algebra or relational calculus. In the former, the user specifies the sequence of relational algebraic operations required to achieve the desired result. In the latter, the user states the result required in terms of relational calculus. The notations and relative merits of these two methods are discussed by Date [10], where he tends to come out in favour of the relational calculus approach, as exemplified by Codd's ALPHA language [12].

There are clear similarities between the report generator system and the relational approach to a data base, for in the former the user specifies the nature of the report he requires but not the sequence of operations required to achieve it.

5.4 DIALOGUE DESIGN

The way in which the user expresses his request for a report varies from one query language to another. In the MARK IV query language [13] the user fills in a standard request for information form which is key punched and processed to produce the report. Terminal based query languages make use of English words and vary in complexity depending on the user's skills and experience. For example, IQF (Interactive Query Facility) [14] is intended for relatively straight forward queries from a terminal by non-specialist users. In contrast GIS (General Information System) [15] is a high level programming language which permits more elaborate data searches and manipulations. It is intended for off-line queries by an experienced user. In this section desirable features of a dialogue with a casual user are considered in relation to the PG/2 macro processor COBOL generating system.

In an outline description of Rendezvous, a query formulation subsystem, Codd [16] draws attention to the fact that the casual

user cannot be expected to be knowledgeable about computer programs, logic or relations, nor can he be expected to learn an artificial language. Codd goes on to identify seven main steps which should be borne in mind during the design stage of a dialogue for use with a casual user.

Two steps outlined by Codd for his Rendezvous system are beyond the scope of the PG/2 macro processor being used to generate COBOL programs, because they make use of text analysers and synthesisers. Word transformers and access to large vocabularies are also required. These steps cover the following points:

1. The translation of the user's source statement into an internal high level language, e.g. data sublanguage ALPHA, in order to detect semantic incompleteness, incompatibility or ambiguity.

2. The restatement of the user's query by the system so that the user can check that the system has correctly interpreted his request.

The PG/2 macro processor could be used to provide Codd's third step but it would be inefficient:

3. The provision of a definition capacity for terms used during the formulation of the query.

A better approach would be to allow the Data base Administrator to define, at the user's request, some 'standard' macros which the user could then invoke in order to perform standard tasks.

The remaining four points made by Codd about dialogue design are, however, applicable to the COBOL generating system using the PG/2 macro processor:

4. Select a simple data model.

5. Introduce clarification dialogue of bounded scope.

6. Separate query formulation from data base search.

7. Employ multiple choice interrogations as fall back.

The fourth point is concerned with the user's view of the data. The user's view should have enough structure to enable him to identify rapidly and concisely the part of the data base which interests him. Codd concludes that the relational view provides the right balance between too much and too little structure.

While the fifth point above specifically refers to a system with a very free format for query formulation, the principle of clarification can be applied to the more confined situation of a computer dominated/ user dialogue for use with the COBOL generating system. By asking follow up questions, the generating system can establish the user's requirements more precisely. Clarification can also be achieved by the insertion of examples in the explanatory text output by the COBOL generating system. The tutorial approach can be taken further by the provision of a 'help' facility when the former proves inadequate. The options available and the way in which the 'help' facility can be invoked are covered in detail in Section 6.2.3. They include a restart procedure and the facility to view the dialogue which solves a predefined model problem.

The sixth point above is particularly applicable to a COBOL program generating system. For while the computer/ user dialogue, which defines the problem to be solved, takes place in the foreground mode, the generation and execution of the COBOL program, which is effectively the data base search stage, are designed to operate in background batch mode (Figure 6.1).

Although Codd in his Rendezvous system, with its text analyser, synthesiser and dialogue control mechanisms, envisages the use of multiple choice interrogation as a fall-back measure, this approach is fundamental to systems with less capacity for analysing user's replies. From the casual user's point of view

the smaller the amount of typing required of him by the system, the fewer will be the keying mistakes he is likely to make. The approach adopted in the COBOL generating system is to reduce, as far as possible, the multiple choice to only two options, one of which is designated the default option.

The three following topics cannot readily be reduced to simple yes/no questions:

1. Specification of conditions for the retrieval of data.
2. Report layout design.
3. Own code processing.

Only the dialogue for these topics is examined further in the following three sections of this chapter. The remainder of the report requesting dialogue, which requires one word responses or poses simple yes/no questions, is illustrated by the model problem dialogue in Appendix IX.

The key features of a computer dominated dialogue may be summarised as follows:

1. The computer prompt - asking for a specific item of information.
2. The user's response - as brief as possible.
3. The follow up prompts - asking for more detail, i.e. clarification.
4. The error messages, help, back-up and recovery procedures.
5. The use of default options.

5.5 SPECIFICATION OF CONDITIONS FOR DATA RETRIEVAL

In order to solve a problem using the COBOL generating system the user will not always wish to view all the tuples retrieved from his relation(s). Some facility, which enables only the data from relevant tuples to be included in the report, must be provided. There are three main approaches by which a user can be encouraged to specify the conditions to be satisfied by data for inclusion in the printed report, viz:

1. Relational calculus.
2. Decision tables.
3. English language format conditional statements.

The use and ease of implementation of the approaches are discussed in the following paragraphs.

5.5.1 Relational calculus

For the casual computer user the relational calculus approach is highly inappropriate. Extensive tutorial dialogue by the system would be required in order to explain the uses of the unfamiliar boolean operators $\wedge$ (and), $\vee$ (or) and $\neg$ (not). The use of the comparison operators =, $\neq$, $<$, $\leq$, $>$, $\geq$ and the parentheses necessary to enforce the desired order of evaluation would also require much tuition.

Essentially, the non-programmer user simply cannot think in terms of relational calculus, nor can he begin to construct multi-term conditionals, let alone nested conditionals. The validation and translation into COBOL of such a relational calculus statement would also prove a long and relatively complicated task using the PG/2 macro processor facilities.

5.5.2 Decision tables

Decision tables provide a simple tabular representation of complex decision logic and were developed primarily as a device for man-to-man communication. Their structure is based on four quadrants, namely condition stub, condition entry, action stub and action entry (Figure 5.4). The simplest form of decision table is the limited entry table, where the rules are defined in terms of Y (yes) or N (no) entries against the condition stub entries. In the situation where a particular condition is irrelevant a dash (-) or an I is entered in the table. The actions to be taken if the rule is satisfied are denoted by X's against the action stub entries. For example, in Rule 2 of the decision table illustrated in Figure 5.4, action-1 is only taken if condition-1 is not satisfied and condition-2 is satisfied. Condition-3 is not relevant to Rule 2.

	Condition Entries			
Condition Stub	Decision Rule 1	Decision Rule 2	Decision Rule 3	Decision Rule 4
condition-1	Y	N	N	N
condition-2	-	Y	N	N
condition-3	-	-	Y	N
Action	Action Entries			
action-1	X	X	X	
action-2				X

Figure 5.4 Limited entry decision table format

The techniques for the detection of redundancy, contradiction and incompleteness in decision tables are outlined by Pooch [17]. In this paper Pooch surveys the currently available decomposition and translation algorithms for communicating

decision table information from man-to-computer.

Decision tables are commonly used in report generators, e.g. Filetab [7], and in COBOL program generators, e.g. Cobra [18], but these software packages are tools for the programmer rather than the casual user.

Although decision tables give a reasonably natural description of selection logic, considerable effort would be required to develop a tutorial dialogue to instruct the casual user in the use of even limited entry tables. The problem of decision table validation would then have to solved.

Two kinds of validation would need to be carried out on a decision table produced by an inexperienced user - format validation and content validation. The format validation would involve the checking of the condition and action stub entries and the column alignments of the condition and action entries. The content validation would involve checks for redundancy, contradiction and completeness.

The content validity checks and the algorithms for translating decision tables into COBOL program statements require the use of vectors and masking techniques, which are not available in the PG/2 macro processor facilities. This was the prime reason for the rejection of decision tables as a means of specifying conditional processing in the COBOL report generating system.

5.5.3 English language format conditional statements

To the casual user the adoption of english language format conditional statements is more natural than the alien notations of relational calculus or the less familiar decision tables. The use of easily remembered mnemonics for the condition operators enables a simple conditional statement, consisting of two operands separated by the operator, to be typed in on a single line by the

user, e.g.:

```
ACCOUNT-NUMBER .LT. TRANSACTION-NO          (less than)
QTY-ON-HAND .NOT GT. 400                    (not greater than)
PART-NAME .EQ. "NAILS"                      (equal)
```

In turn, this enables the string extraction facilities of the PG/2 macro processor to be exploited to advantage during the validation and translation into COBOL of each simple condition.

Although the use of parentheses would remove ambiguity and allow the creation of complex logical expressions, such expressions are both hard to form and hard to understand if they contain several (more than two) levels of nesting. The implementation and validation of such complex expressions would also be difficult using the PG/2 macro processor facilities. It was not therefore pursued. The non-provision of parentheses for conditional statements is characteristic of other COBOL generating systems, e.g. SURGE [19], which is not self-tutorial and uses fixed format card input.

Compound conditions can, however, be built up from simple conditions, without the use of parentheses, by the selection of appropriate AND/OR conjunctions. Essentially a system is devised where the computer is in control of the dialogue, and where the user is asked to provide only a small amount of information at a time. Simplicity is achieved at the cost of efficiency and flexibility, for after an OR conjunction the user has to be prompted to enter again previously typed conditions which still apply.

e.g. The following complex conditional statement would have to be entered as eight simple conditions after selecting seven AND/OR conjunctions:

```
IF ((EYES .EQ. "BLUE") .OR. (EYES .EQ. "GREEN")) .AND.
   ((HAIR .EQ. "BROWN") .OR. (HAIR .EQ. "BLACK"))  ... etc.
```

Thus:

```
IF
EYES .EQ. "BLUE"
AND
HAIR .EQ. "BROWN"
OR
EYES .EQ. "BLUE"
AND
HAIR .EQ. "BLACK"
OR
EYES .EQ. "GREEN"
AND
HAIR .EQ. "BROWN"
OR
EYES .EQ. "GREEN"
AND
HAIR .EQ. "BLACK"
```

The above approach is adopted in the dialogue for the specification of conditions for data retrieval in Stage 7 of the COBOL generating system (7.14). The two routines used, Specify condition (Appendix VII Section 15.1) and Validate condition (Appendix VII Section 15.2), are generally applicable to other situations where the processing may be conditional, e.g. own code processing.

In order to improve the legibility and clarify the structure of a user's compound conditional statement, it would be possible to restate it on his terminal in an indented form and without the intervening computer prompts. Further the labour of entering a complex conditional statement could, in some cases, be reduced by adopting the convention that default responses, entered after the selection of the OR conjunction, imply that previously specified simple conditions are repeated (and these could be listed on the terminal.).

An alternative approach, whose implementation was not attempted, would be a facility for defining sets of values and permit conditional operations on these sets. Facilities to re-define a set in terms of existing sets and/or elements would also be required. Using this approach the previous example of a

compound conditional statement could be written:

```
SET EYE-COLOUR = ("BLUE", "GREEN")
SET HAIR-COLOUR = ("BROWN", "BLACK")

IF
EYES .IN. EYE-COLOUR
AND
HAIR .IN. HAIR-COLOUR ... etc.
```

The more complicated the bracketing used in a compound conditional statement, the more difficult it becomes to write it out in terms of simple conditions. Ideally the computer's prompt and reply system should give the user some idea of how his conditional statement is structured. The user really needs to be able to 'test his logic' on some typical data records (6.7).

5.6 REPORT LAYOUT DESIGN

Consideration is now given to the format in which the user is prompted to enter the specifiactions for the various types of line in his report and the field editing facilities provided.

Although the COBOL generating system described in Chapter 6 offers the user the default option of allowing the system to format the layout of the required data, according to a set of simple rules, many users will want to exercise their freedom to specify their own layouts.

The amount of preplanning required to design a report layout depends on the report producing system, its input device and mode of operation. It can range from a simple sketch to a detailed design on squared paper.

The manner in which the actual report line formats, including the required editing and insertion of punctuation and text, is described to a report producing system falls into two main types.

The first type necessitates the transcription of a detailed

preplanned pictorial layout for each type of report line into statements. These give details of the starting position, width, type (numeric, alphabetic, text, etc) and editing requirements, if any, for every data field in the print line. The starting position of any field is quoted either relative to the preceding field or relative to the beginning of the line. These format specifying statements may be in a relatively free format, as in COBOL, or in the strict format of the more concisely expressed RPG type languages.

The second type of report line format specification uses the pictorial approach as exemplified by Filetab, where each character in the line format specification represents one print position within the line. The Filetab approach is very suitable for an interactive report generating system as the user can design the report layout in detail while sitting at a terminal. This is especially true if the terminal is a visual display unit. The preplanning stage is minimal and the tedious transcription of a line format into detailed field specification statements is avoided altogether.

Filetab uses a Field Specifying Character to denote the field type and as a means of describing the print positions to be occupied by the field in a line of the printed report (Appendix II). Predefined character ranges are used to denote the field type, for example the characters M N O P Q and R are used to denote control fields. A slightly less restrictive approach is adopted for the present COBOL generating system. For each data item to be printed the user is invited to select a label character from a list of permitted characters without reference to item type. The latter is determined by the generating system from one of its subfiles, which contains details of the user's data base submodel. The character list contains most of the

alphabet, the exceptions being those characters which are used to denote editing requirements. From the available characters which are shown below, there is a reasonable opportunity to choose an appropriate mnemonic for a data item:

A E F G H I J K L N O Q T U V W X Y Z

The editing facilities offered to users of the COBOL generating system have been chosen to provide a useful selection from those available in Filetab and COBOL. The aim has been to provide the user with enough editing facilities to meet the requirements of most reports. The editing facilities could be extended to meet any reasonable requirement, but the penalty would be more complex processing and possibly a more complicated user interface. A balance between extremes has been sought in the realistic facilities described below.

The actual editing facilities available for use with any item are determined by the type of data the item contains. Thus alphanumeric data items are always left justified in the allocated print positions and two editing characters are available for use. These are the insertion characters B and O, where B is used to denote the insertion of a blank character and O the insertion of the Ò digit. These two insertion characters are also available for use in editing numeric items.

The decimal point of a numeric report item is assumed to be after the right-most digit of the field specification, unless otherwise indicated by the presence of the full-stop character. The decimal point in the actual data to be output is always aligned with that implied or specified in the output format. The leading zeros of a numeric item appearing in a printed report are suppressed, unless use is made of the currency symbols, £ and $, the cheque protection character *, or the + and - signs. Fuller details of the rules governing the use of these editing characters

together with the comma insertion character and the report credit and debit signs, CR and DB, are given in Section 6.5.9.

It tends to be difficult to judge how many blank characters have been typed between the various fields when keying in a report line specification at a terminal. To overcome this problem the COBOL generating system asks the user to key the visible character # to denote inter-field spaces. This is required only before and between fields and not for the blanks at the right-hand end of a line. A print line specification such as that shown below would be used for a report line which might look as that shown beneath it:

```
#####NNNN#####IIIIIIIIII#####£KK.KK
     324    FOOT PUMP       £9.07
```

The tutorial dialogue for prompting the user to enter the various heading, detail and totals line specifications is illustrated in Appendix IX.

Two other facilities to help the casual user and to reinforce the tutorial dialogue are provided by the COBOL generating system. The first enables the user to experiment with the use of editing characters, while the second permits the viewing of the layout for a complete report page.

The experimental editing facility enables the user to design an edit format and have it validated. The system then invites the user to type a value which, if valid, is edited into the desired format and output for the user's inspection. The following is typical of the dialogue produced when using this facility:

```
USING A VALID LABEL CHARACTER PLEASE TYPE THE DESIRED OUTPUT FORMAT
-£AAA.AA
PLEASE ENTER THE VALUE OF THE NUMERIC ITEM TO BE EDITED INTO THE
ABOVE FORMAT
27.87
AFTER EDITING YOUR NUMERIC ITEM WILL LOOK AS FOLLOWS:
  £27.87
```

The facility to view the format of a complete page enables the user to get an overall impression of the report layout and, if necessary, to change his mind before running the generated program with real data. The aim is to give the user a view of the spacing between the page heading and sequence break headings and also the alignment of the detail, subtotal and total lines. All the visible space characters and literal delimiters are replaced by blanks, while all the item edit pictures remain unchanged. Sufficient detail lines are generated to fill a page containing an example of each other type of report line. Thus the view presented to the user is analogous to the system analyst's squared paper report layout sheet. Further details of this facility are given in Section 6.5.11.

5.7 OWN CODE PROCESSING

The user's data base does not always contain the data in exactly the form he requires, e.g. details of the quantity in stock and the unit value of various items are available, but the user wishes to report on the total value of the stock. In such cases the provision of own code facilities, which enable the user to specify the calculations needed for the required information, are useful. Consideration is now given to the own code facilities offered by the PG/2 macro processor COBOL generating system.

In order to supplement the basic processing facilities of the COBOL generating system described in Chapter 6, the user may insert own code processing at various places within the generated program, e.g. after a data retrieval or before writing a report line. The dialogue for own code specification falls into several parts and is a combination of:

1. Direct questions with yes/no replies.

2. Default options.

3. More complicated tutorial dialogue for the specification of the own code data manipulations.

Examples of dialogue to illustrate the own code facilities are to be found in Appendix IX Section 18.

The introductory stage of the own code dialogue sets out the various points during the processing of the user's data at which own code processing may be carried out. The user is prompted to indicate if he wishes to avail himself of the facility. Once the user has signified interest the tutorial dialogue gives details of the own code operations together with examples. Initially the system makes provision for four arithmetic operations - addition, subtraction, multiplication and division. One data transfer operation is also provided.

The COBOL language allows two formats for specifying arithmetic processing. The first is the powerful COMPUTE verb, which permits complicated formulae to be expressed using a combination of parentheses, data-names and arithmetic operator symbols (+, -, * and /). For example:

```
COMPUTE AVERAGE = ( VALUE-1 + VALUE-2 ) / 2.
```

The second approach, although more verbose, allows the step by step evaluation of items by considering only one arithmetic operation at a time. It also has the advantage of clearly defining where intermediate values, if any, are to be stored, e.g.:

```
ADD VALUE-1, VALUE-2 GIVING SUM.
DIVIDE SUM BY 2 GIVING AVERAGE.
```

For ease of implementation and ease of use by the casual user, an approach similar to the second of the two COBOL forms was adopted for use in the COBOL generating system. The validation of complicated statements of the COMPUTE type would be difficult to implement using the PG/2 macro processor facilities. This is

because they may consist of arithmetic expressions nested by parentheses and require more than one line of keyed input when entered by the user. Problems similar to those outlined in Section 5.5 where complex conditional statements were considered would arise.

The main advantage of adopting the single operation per user statement approach is that the user can develop the calculation, step by step, while sitting at the terminal. There is no need to preplan the coding of complicated formulae, e.g.:

```
MULTIPLY ITEM-COUNT BY ITEM-COST GIVING NET-PRICE
MULTIPLY NET-PRICE BY VAT-RATE GIVING VAT
ADD NET-PRICE, VAT GIVING SALE-PRICE
```

The simplified forms of the COBOL verbs ADD, SUBTRACT, MULTIPLY, DIVIDE and MOVE can all be expressed in one line of output without undue restrictions on the number of characters allowed for domain or temporary item names. This enables the string extraction facilities of the PG/2 macro processor to be exploited during the validation of the user's own code statements. Once validated these user coded statements are used as the basis for the generation of COBOL statements for the report producing program. In general the data names in the user's statements require further qualification to make them unique for use in the generated program. This is because, although the user takes the relational view in two dimensional tabular form, the actual items are extracted from various files and reorganised into tuple form.

When a user has taken advantage of both the own code and accumulated totals options, the COBOL generating system provides additional instructional text to explain how limited use of the totals may be made in the own code statements. This is achieved by instructing the user to preface data names by a special character to denote the current total for an item instead of the currently retrieved item value. In all situations where own code

processing is allowed, the user is invited to state if his own code is conditional and, if so, to specify the conditions.

The validation and generation of the COBOL statements from the user's own code entries is covered in more detail in Section 6.6.4.

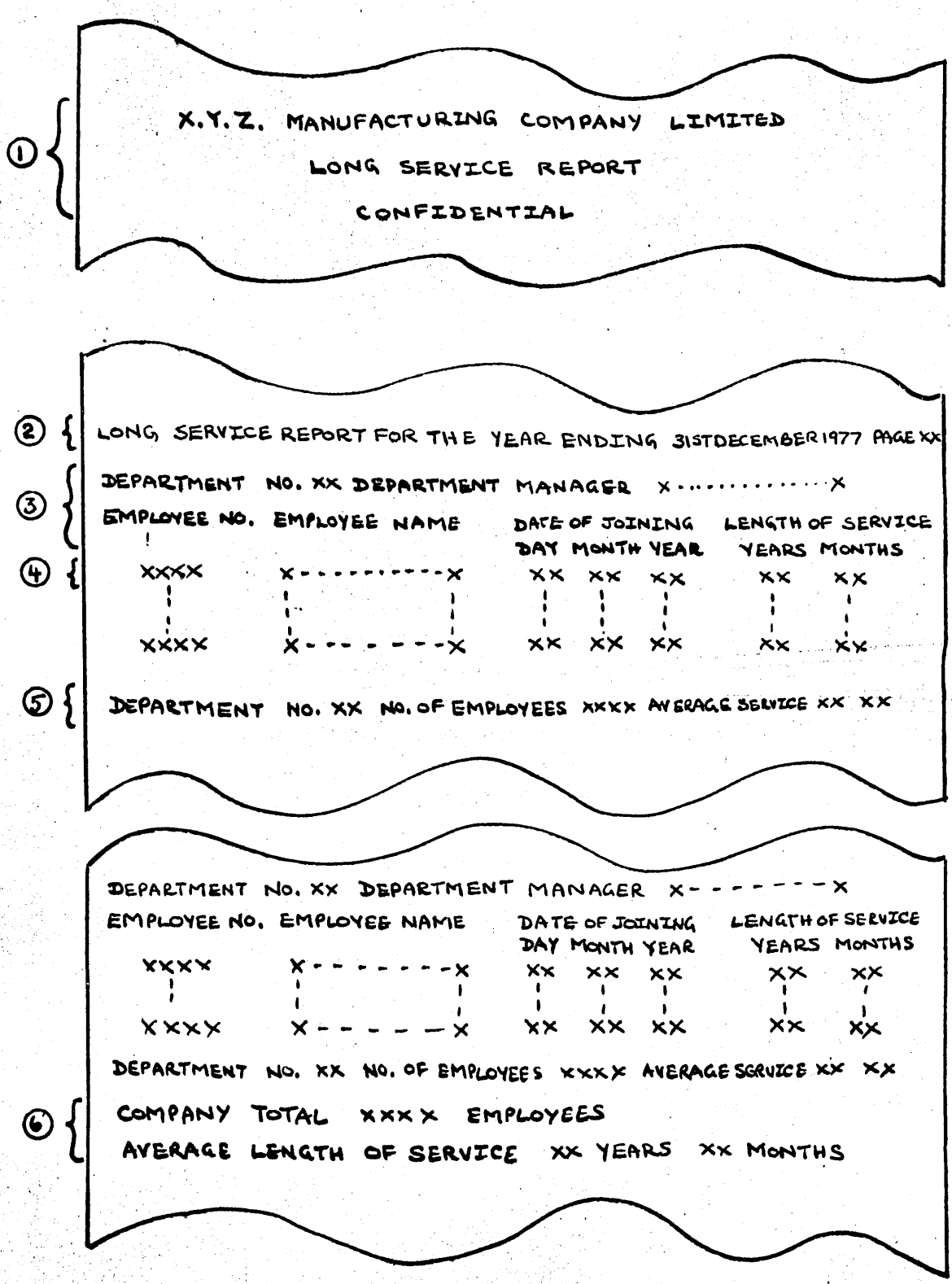
5.8 USER FEEDBACK

For any particular problem the information to be gathered from the user by the COBOL generating system remains essentially the same, but a flexible approach to the dialogue by which the information is gathered should be maintained. One advantage of using a macro processor for the COBOL generating system is that it should be possible to revise the dialogue easily and/or provide new facilities.

Different users come from different backgrounds to solve a wide variety of problems. The feedback of their comments on the ease of use and clarity of the dialogue is an essential factor in the development and maintenance of any system which adopts the tutorial approach. As an encouragement to the user to make comments while they are fresh in his mind, he is invited to type in comments after he has specified his problem requirements. The comments are stored in one of the PG/2 macro processor subfiles, whence they may readily be retrieved by a system designer. The users' comments may then be taken into account at the periodic reviews of the facilities available and dialogue effectiveness, which should play an important part in the maintenance of the COBOL generating system.

The introductory dialogue for the use of the comments facility is illustrated in Appendix IX towards the end of Section 18.

Figure 5.5 Sketch of the required report layout



① Report title

② Page heading

③ Sequence break heading

④ Detail line

⑤ Sequence break subtotal

⑥ Totals output

5.9 DEFINITION OF A MODEL PROBLEM

The following model problem was designed to serve two main purposes. First, it is used in Appendix IX to illustrate the text of the computer dominated user/system dialogue produced by the COBOL generating system described in Chapter 6. Secondly, all users of the COBOL generating system are made aware of the model problem's existence prior to starting to use the system. Should they experience difficulty in defining the requirements of their own problem to the system at any stage, they can view the model problem dialogue at the corresponding stage, by means of the %HELP facility (6.2.3).

5.9.1 Model problem

At the end of the 1977 calendar year, the directors of the X.Y.Z. Manufacturing Co. Ltd. planned to give a bonus to all employees who would have completed 10 or more years of service with the company. The managing director therefore required a list by department of all employees who would be eligible for the bonus. He wanted the list to give details of employee number, employee name, date of joining the company and length of service in years and months. For each department and for the company as a whole, he also wanted to know the number of employees eligible and their average length of service. Employees joining the company during the month of January in any year were allowed to count that whole year as part of their service.

Figure 5.5 illustrates the layout of the required report. The following two paragraphs describe the data base details and the additional data items which have to be created and computed for inclusion in the report.

5.9.2 Data base details

The data needed to provide the required report is contained in three relations which would already exist, having been created for other purposes.

In order to gain access to the required information, the user must have been supplied with the passwords which permit access to the level 4 data in the DEPARTMENT and STAFF relations and the level 3 data in the PERSONNEL relation. (Level 1 is the highest security level used for the protection of sensitive or confidential data.)

The details of the three relations are as follows:

DEPARTMENT relation

Domain names	Security level
DEPT-NO	4
DEPT-NAME	4
DEPT-LOCATION	4
DEPT-MANAGER	4

Sequence key DEPT-NO

STAFF relation

Domain names	Security level
DEPT-NO	4
EMPLOYEE-NO	4
EMPLOYEE-NAME	4

Sequence keys DEPT-NO, EMPLOYEE-NO

PERSONNEL relation

Domain names	Security level
EMPLOYEE-NO	4
ADDRESS	3
SEX	4
MARITAL-ST	3
AGE	2
JOIN-YEAR	3
JOIN-MONTH	3
JOIN-DAY	3
SALARY	1
TAX-CODE	2

Sequence key EMPLOYEE-NO

5.9.3 Additional data items

Some own code processing is required to solve the model problem since length of service and average service have to be computed from the date of joining information. In order to carry out these calculations and to count the number of eligible employees, the user has temporarily to extend the data base by creating the following numeric items:

L-O-S-YEARS
L-O-S-MONTHS
NO-EMPLOYEES
AV-SER-YEARS
AV-SER-MONTHS
WORK-ITEM
MONTHS-SERVICE

The names chosen are quite arbitrary, the only conditions being that they must not duplicate existing names in the user's data base, not exceed 15 characters in length and satisfy the rules for COBOL data names. WORK-ITEM provides a useful means of storing intermediate results during the own code processing.

A compound domain JOIN-DATE is also created by concatenating the data items from the JOIN-DAY, JOIN-MONTH and JOIN-YEAR domains.

A listing of the dialogue for the solution of the model problem is given in Appendix IX. The listing is separated into separate stages to make cross referencing easier. The dialogue has been manually fabricated for those problem specifying macros whose development is incomplete or have not been implemented (7.1). No attempt has been made to illustrate the many error messages which invalid user responses might provoke.

5.10 SUMMARY AND APPRAISAL

In a viewpoint on computer language design, Tucker [20] describes a 'very high level' language as one which enables the user to express, in familiar terms, what is to be done rather than how it is to be done. The dialogue in which the casual user specifies his request for a report to the COBOL generating system is akin to a 'very high level' language, in that the user specifies the content and form of his report, but does not specify how the report is to be produced.

The casual user is presented with a simple view of his data which does not require knowledge of its physical organisation. The relational approach used in the dialogue allows the user to view his data in a familiar tabular form.

The computer dominated dialogue aims to instruct the casual user and prompt him to supply specific items of information as briefly as possible. This includes the use of default options and, in some instances, follow up prompts requesting more detail. Some aspects of the dialogue do not lend themselves to brief responses, e.g. data selection, report layout design and own code processing. The dialogue for these aspects of the report specification is influenced by the constraints imposed by the PG/2 macro processor facilities and the type of terminal available for system development. The dialogue also provides facilities for help, trial editing, resuming the dialogue at an earlier stage, model problem and sample page viewing and gathering users' comments.

In a discussion of data base interrogation languages, Martin [7] concludes that it is desirable that they should operate on standard data structures by means of an on-line computer initiated dialogue. Other desirable characteristics listed by Martin are that the dialogue responses should be in a fixed format using two

dimensions and entered by means of a light pen. The COBOL report program generating system uses standard flat data files and, subject to the limitations of the PG/2 macro processor and a teletype terminal, the dialogue goes some way towards exhibiting the desirable characteristics advocated by Martin.

Although the dialogue illustrated in Appendix IX shows that it is feasible to specify a request for a report by means of a computer dominated dialogue, a complete operational system is necessary before the dialogue can be fully appraised. Only when the users' reactions to the clarity, naturalness and simplicity of the dialogue have been analysed can its effectiveness be assessed. Ways in which assessment data can be gathered are considered in Section 8.5.

CHAPTER 6

SYSTEM SPECIFICATION

6.1 INTRODUCTION

The COBOL report program generating system, designed for implementation using the PG/2 macro processor, adopts a relational view of the data and uses a computer dominated dialogue for communicating with the casual user. The design and system specification details are presented in this chapter under five main headings:

1. The system overview which sets out the main benefits of the COBOL report program generator and relates its overall structure to that of the host computer's operating system.

2. The design and maintenance of the Catalogue containing descriptions of the data files.

3. The processing of system input in the form of the Catalogue and the user's data files.

4. The report output facilities including the form of the output file and the design of a report page.

5. The data manipulation facilities which include the provision of additional data items, both system and user created, the totalling facility and the use of own code and conditional statements.

The chapter concludes with a summary and appraisal.

6.2 SYSTEM OVERVIEW

This section sets out the main aims and benefits of the COBOL report program generating system and relates its overall structure to the operating system of the host computer. Features which contribute to more efficient computer usage are noted. The stages into which the problem specifying dialogue is segmented

are identified and the provisions of the 'help' facility are outlined.

6.2.1 Aims, benefits and proposals

The main aims which have influenced the overall design of the COBOL generating system are as follows:

1. Use of man/computer computer dominated dialogue as the basis for generating COBOL programs to solve a limited range of data processing problems.

2. Make it 'easier' for the casual user to use the computer by adopting a tutorial approach and taking a relational view of the data.

3. Make a contribution towards helping the user to use the computer more efficiently by reducing wastage in terms of time and resources at the man/computer interface.

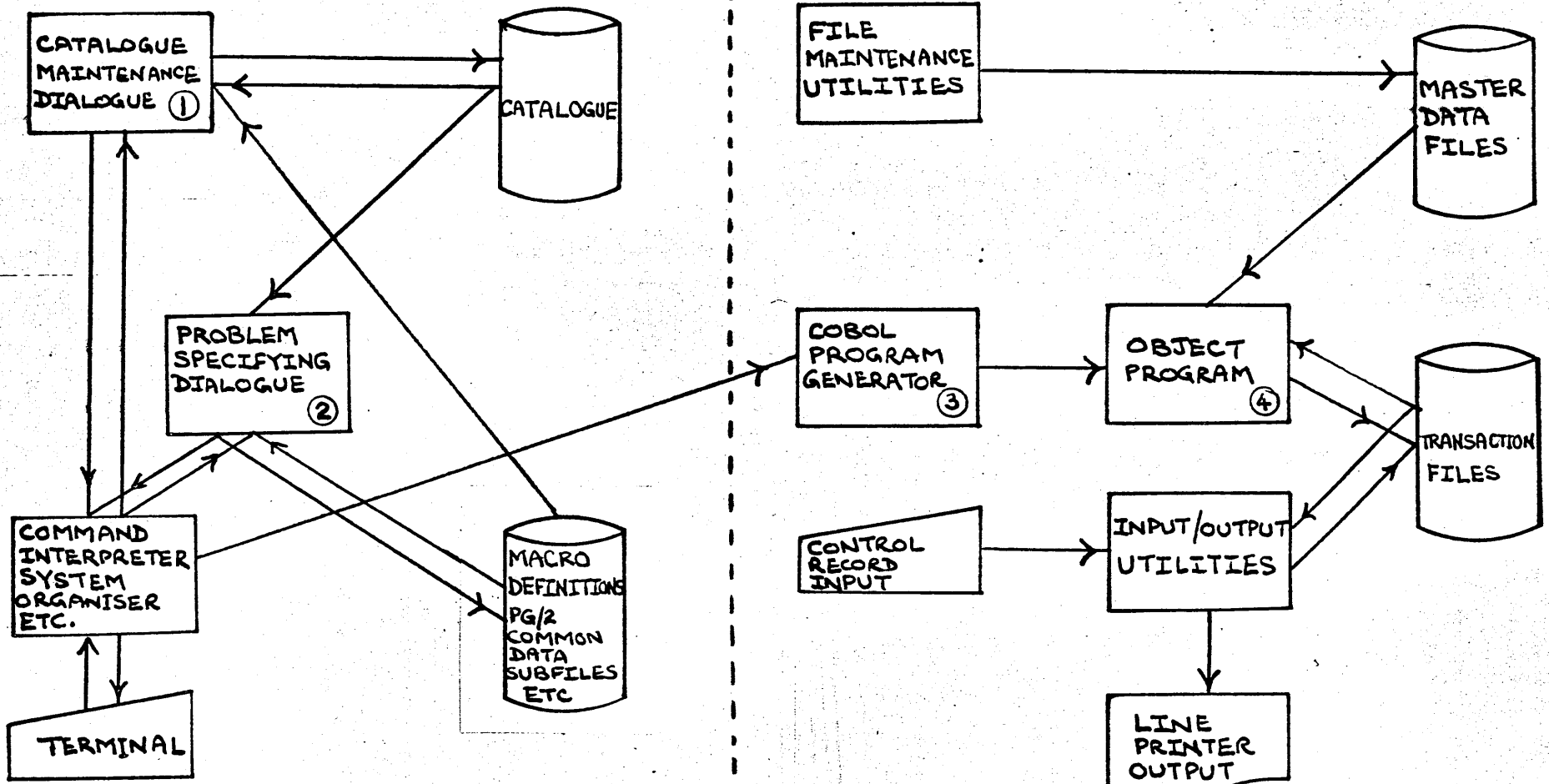
4. To offer some of the benefits of a data base management system.

The range of data processing problems which may be solved using the COBOL generating system has initially been restricted to the generation of reports using sequentially organised flat data files. The system has, however, been designed with a view to determining the potential for enhancement (and avoiding unnecessary restrictions) so that it may then be used to solve a wider range of problems. There is potential for solving problems which may require the creation and/or updation of data files whose organisation can include direct access.

The benefits of the data base management system approach accrue in that:

1. The physical organisation of the data files does not concern the user as he has only to take a relational view of the data.

Figure 6.1 Report program generating system



PG/2 Environment: running under time-sharing

Foreground jobs

Operating system, utility programs, COBOL system running under batch

Background jobs

2. Sensitive data is afforded some protection by a system of passwords. Different users will have access to different data items depending on the security level of the passwords they are allocated.

The system to generate a report falls into four main parts:

1. The creation and maintenanance of the catalogue of data file descriptions.

2. The problem specifying dialogue.

3. The generation of the COBOL program.

4. The compilation and execution of the generated program to produce the required report.

Only the second part is carried out by the casual user, although he may initiate the execution of part three. Figure 6.1 shows how the above tasks relate to each other, to the PG/2 macro processor and to the operating system of the host computer.

As aids to helping the user make more efficient use of the computer the following features are incorporated:

1. Only the problem specifying dialogue is carried out in foreground mode. Once the problem details have been 'filed' they are passed across to the system so that the generation, compilation and execution of the COBOL program may be carried out as a batch job in background mode.

2. The user is allowed some opportunity to experiment with the design of report page layouts and field editing. He is also able to view a stylized page before committing himself to a full production run.

3. The dialogue is check pointed to allow it to be restarted at a previous stage.

4. There is a 'help' facilty which offers the user various options including the chance to view the dialogue for solving the model problem and the opportunity to change his mind about

earlier decisions by restarting the dialogue at a previous check point.

6.2.2 Check point stages

The problem specifying dialogue is segmented into eighteen check pointed stages which, in association with the %HELP facility, enable the user to change his mind about decisions made in a previous stage. Each stage covers a new aspect of the problem specification and is introduced by some instructional text, the first line of which introduces the stage. The user's problem may not require the use of all the stages which are listed in order below:

1. Introduction
2. Password dialogue
3. Data base submodel
4. Selection of relevant domains
5. Temporary extensions to the data base
6. Data base inconsistencies
7. Selection of data for retrieval
8. Report layout introduction
9. Editing
10. Detail line(s) specification
11. Extra data items - date, time, page number
12. Report title specification
13. Page heading specification
14. Sequence break heading specification
15. Subtotal line(s) specification
16. Total line(s) specification
17. View of sample report page
18. Own code processing

In general, the stages are carried out in serial order although, in Stage 17, there are provisions for repeating any of the line format specification stages if the user is dissatisfied with his design.

6.2.3 Asking for help

The 'help' facility may be invoked by typing the five character string '%HELP' in reply to any prompt at any stage during the problem specifying dialogue.

Initially the following options will be available to the user when he enters a plea for help:

1. Abandon the dialogue.

2. Restart the dialogue at the beginning of the current stage or at a previous stage.

3. To view the dialogue for the corresponding stage of the sample problem and resume processing at the beginning of the current stage.

4. To experiment with editing data and then resume the dialogue at the beginning of the current stage. (This option is only available to users who have already reached Stage 9 where editing is introduced.)

As each stage depends on information gathered in an earlier stage it is, with the exception of the report layout specification stages, not possible to provide facilities for repeating just one stage.

6.3 THE CATALOGUE SYSTEM

This section describes the security mechanisms which protect the catalogue of file descriptions and identifies the basic processes which are required to maintain it. The catalogue structure is described together with the constraints which influenced the design of record formats. The macro definitions used for catalogue maintenance are described in outline. The chapter concludes with a brief appraisal of the catalogue handling system.

6.3.1 Catalogue maintenance and security mechanisms

The catalogue of file descriptions is located in the PG/2 macro processor CATALOGUE subfile and is maintained by a number of macro definitions which carry out a dialogue with the user. As it is envisaged that the catalogue will be maintained by an experienced user, the Data base Administrator, the dialogue does not attempt to be tutorial. Extensive validation of the user's responses is, however, carried out.

The catalogue is protected by a single password and the data items within each file description are protected by a series of passwords. The latter define different levels of access and are dual purpose for they limit access to data and permit creation of different views of the data.

Up to twelve levels of access are permitted for file descriptions, but this is an arbitrary limit which can readily be extended should the need arise. Any user may have read access to a file description providing he is able to supply a valid password for that file. The amount of information to which access is allowed is determined by the security level of the password supplied. A password for one security level

automatically grants access to that level and all levels below it. The highest security level is 1, so the password for level 3 grants access to data with security levels 3 to 12 inclusive. If different users are allocated different passwords for the same file, they will have different views of its contents.

Initially macro definitions are provided for:

1. Creating an empty catalogue.
2. Changing the catalogue password.
3. Inserting or deleting file descriptions.

These can readily be supplemented to provide facilities for printing out file descriptions, changing file passwords, etc. The provision of such facilities, however, adds nothing to the research project because no original ideas or techniques are involved.

Only users able to supply the catalogue password may insert or delete file descriptions. In the case of a deletion the highest security level password must also be known. Changes to a file description are effected by a deletion followed by an insertion. The method of record modification is a simple, minimum effort approach. It would be easy to define a macro to access, edit and replace a record, but time consuming to produce it and unnecessary for this project.

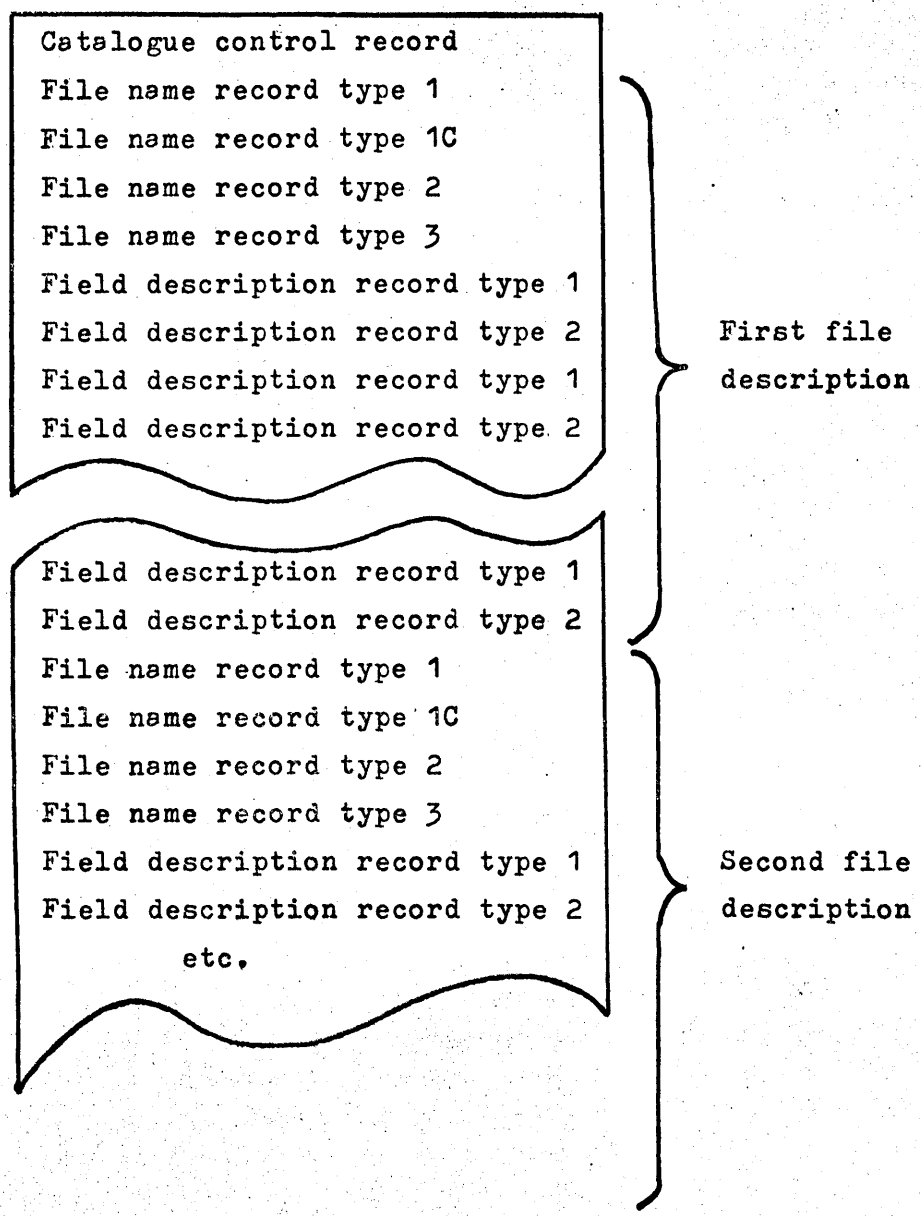
6.3.2 Structure of the catalogue

The catalogue of file descriptions is located in the CATALOGUE subfile of the PG/2 disc based filing system and contains three classes of record:

1. Catalogue control record.
2. File name records.
3. Field description records.

The two latter classes contain more than one record type and are

Figure 6.2 Catalogue structure



repeated for each file described in the catalogue. As many of the fields in the catalogue records contain variable length data a comma is used as the field separator. Figure 6.2 illustrates the catalogue structure.

Catalogue control record:

The CATALOGUE subfile contains only <u>one</u> record of this type and it is the first record in the subfile. The control record contains the following information:

Count of file descriptions in the catalogue

Count of all records in the catalogue

Catalogue password

Number of security levels used for protecting access to field descriptions

Date and time when the catalogue was last updated

The format details of the control record are given in Appendix V (Section 1.1).

File name records:

Each file described in the catalogue has at least three file name records. If the catalogue security system extends beyond four levels then a fourth record will be present. File name records are always followed by the field description records for the same file. The file name records contain the following information.

Type 1 record:

- File name
- Count of the number of fields described in the catalogue
- Passwords, one for each security level up to the fourth

Type 1C record { Passwords for security levels 5 to 12, if used, otherwise this record is omitted

Type 2 record — Description of file contents

Type 3 record {
- File medium
- Maximum block size
- Maximum record size
- File label, if applicable
- Access mode
- Organisation, if applicable
- Length of symbolic key, if applicable
- Number of fields forming the symbolic key or sort key

Although the COBOL generating macros currently restrict processing to sequential files, the file name records have been designed in anticipation that this restriction will be eased at a later date. Format details for the file name records are given in Appendix V (Sections 1.2 to 1.5).

Field description records:

For each field in a file record which is likely to be used by the system a pair of field description records is set up. Not all fields in the record need be made available to the system, but access to those which are is protected by the set of multi-level passwords. Fields may overlap or redefine one another. The inclusion of the password and redefine facilities means that different users will have different record descriptions in the generated COBOL program.

Currently fields are restricted to DISPLAY usage. In ICL 1900 COBOL parlance this means that each character or digit in a

field occupies one ICL six-bit character. Although the COBOL language allows three categories of data (alphabetic, alphanumeric and numeric), it was felt that for the purposes of this study the two latter categories would be adequate. These initial restrictions do not preclude the inclusion of other usages or classes of data at a later date.

The field description records contain the following information:

Type 1 record	Field name
	Security level
	Start position
	Length of field
	Field type
	Decimal point location, if applicable
	Key field indicator
	Sequence order for key fields
	Domain indicator
Type 2 record	Description of field contents

The domain indicator serves to show whether or not the contents of this field throughout the file can be considered to form a domain. For practical purposes, this means that the contents of this field in every record of the file is unique.

Format details for field description records are given in Appendix V (Sections 1.6 and 1.7).

6.3.3 Constraints on the design of catalogue records

The formats for each type of record in the CATALOGUE subfile are given in Appendix V. The restrictions on field size or contents were imposed for two main reasons:

1. Those imposed by the ICL 1900 series COBOL complier or operating system, e.g.

   30 characters for a file name

   12 characters for a file label

   120 characters for the maximum field size

   9 sort keys

   64 characters for the length of a symbolic key

2. Those which seem reasonable to cover most practical applications, e.g.

   File, record and field counts

   Number of security levels

The contents of certain fields is temporarily restricted by the facilities implemented in the initial versions of the macros. For example, binary fields are excluded and only numeric and alphanumeric fields are catered for. The catalogue records are designed to permit the addition of enhancements without changes to the record formats.

The notable exception to the above is the limitation of field names to 14 characters when COBOL would permit the use of up to 30 characters. The computer dominated dialogue with the user restricts responses so that they will fit on one line of the teletype or visual display unit. The problems of user error and response validation are much greater if continuation lines are allowed. The user's condition specifying and own code statements are those where the length of the field name (domain name) becomes critical.

Of the 72 positions normally available on a terminal device one is taken up by the operating system's invitation to type

character. A further character is sacrificed in order to force the invitation to type on to the line following a request for information (Appendix VI Section 1 - PROMPT routine). A maximum of 70 characters is then available for the user's response.

Although the own code statements, which are those where space for domain (field) names becomes most critical, would allow up to 16 characters, this has been reduced to 14 to cope with the following situations:

1. When a non-key domain occurs in more than one relation (file) it is necessary to distinguish between occurrences as their contents may not be identical. Additional numeric characters are suffixed to each duplicate non-key domain name in the user's data base submodel to pad it out to 15 characters. For example, if the non-key domain DELIVERY-COST occurs in two relations, when the data base submodel details are displayed to the user it will be called DELIVERY-COST in the first relation and DELIVERY-COST22 in the second relation.

2. When a user opts to have totals accumulated for the contents of numeric domains (6.6.3) he is allowed access to the totals in own code statements (6.6.5). In order to distinguish between the total of items from a given domain and the a single item from the same domain, the domain name is prefaced by a * character when the total is referenced. For example, if a user has opted to have the contents of the domains DELIVERY-COST22 and MILAGE accumulated, he can calculate AVE-COST-MILE using the following own code statement:

DIVIDE *DELIVERY-COST22 BY *MILAGE GIVING AVE-COST-MILE

The restriction to 14 characters was not felt to be too inconvenient for the data base administrator when he devised meaningful mnemonics for field names. This is especially so as the catalogue includes a description record for each field.

6.3.4 Creation of an empty catalogue

The CREATE macro creates the control record for an empty catalogue (Appendix V Section 1). The macro carries out a short dialogue with the data base administrator to gather details about the catalogue password and the number of security levels by which the data files to be described therein will be protected. The implementation details for the CREATE macro are described in Section 7.4.

6.3.5 Changing the catalogue password

The PASSCHANGE macro enables the data base administrator to change the password in the catalogue control record. The macro carries out a brief dialogue during which the old password must be correctly entered before the new password may be specified. The implementation of the PASSCHANGE macro is described in Section 7.5.

6.3.6 Inserting and/or deleting catalogue file descriptions

A set of chained macros, the Librarian macros, is used to carry out the insertion and/or deletion of file descriptions in the CATALOGUE subfile. The macros are chained because of the large number of macro-time statements needed to gather and validate all the information needed to add a file description to the catalogue. In order to modify a file description it is first necessary to delete the old description before the new description is inserted (6.3.1).

Because the security processing for the insertion and deletion of a file description have common features in the checking of passwords and file names, it is convenient to carry out the catalogue amending processes by means of four macros -

LIBRARIAN, LIBPRELIM, LIBADD and LIBDELETE. Figure 6.3 illustrates the function and linkage of the macros. The implementation details for the Librarian macros are described in Section 7.6.

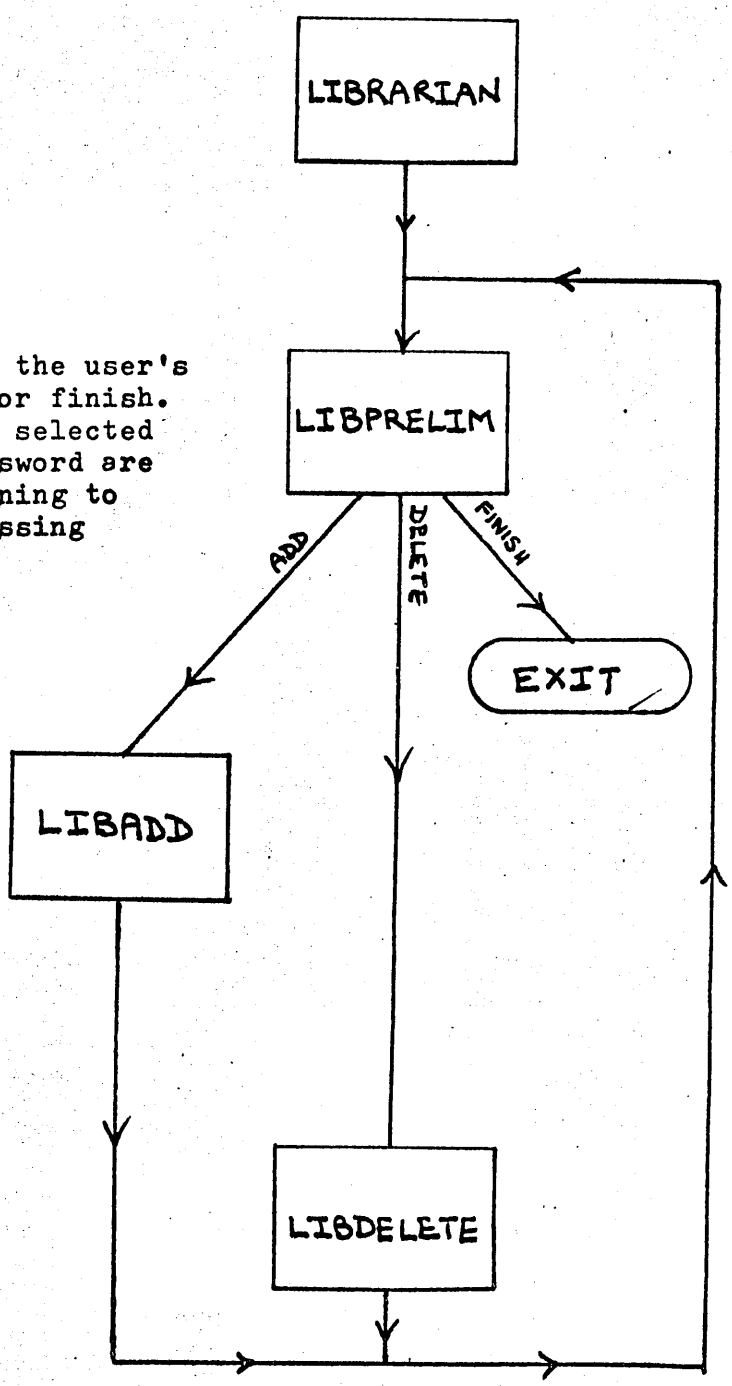
Figure 6.3 Librarian macros for catalogue maintenance

Password dialogue for catalogue access.

Dialogue to establish the user's option - add, delete or finish. When add or delete is selected the file name and password are requested before chaining to the appropriate processing macro.

Dialogue to gather information about the new file. Insert the description in the catalogue and update the catalogue control record.

Delete the file description from the catalogue and update the catalogue control record.



6.3.7 Appraisal

The catalogue system with its dual purpose passwords enables the COBOL report program generating system to present a relational view of the data base to the casual user. Enhancements to the COBOL generating system, which extend the range of acceptable field or file types, can readily be accomodated within the present catalogue format.

The macro definitions specified are the minimum necessary to maintain the catalogue for use by the COBOL generating system. The Librarian macros for inserting and deleting file descriptions frequently access the CATALOGUE subfile and their run time efficiency is adversely affected by the inefficient implemenataion of the PG/2 macro-time statements for subfile access (4.8.2). This problem aside, there is considerable potential for extending the range of facilities available to both the data base administrator and the casual user for accessing catalogue information.

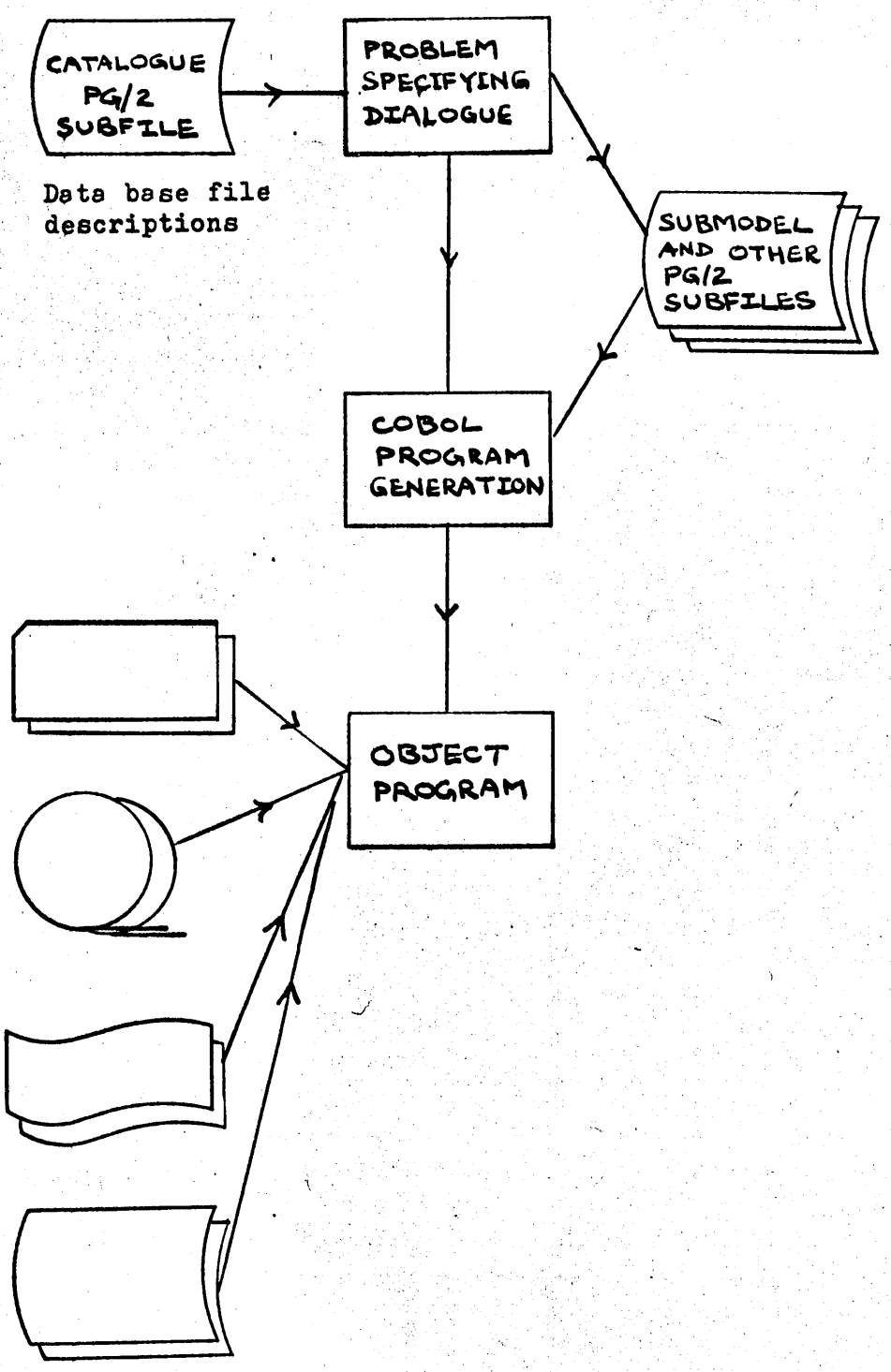
6.4 INPUT PROCESSING

The description of the report program generator part of the system starts with this section which deals with input processing. The use made of the catalogue of file descriptions and the implications of using more than one input file to solve the user's problem are discussed. The input to the report generator part of the system is summarised diagramatically in Figure 6.4.

6.4.1 Input file descriptions

Descriptions of all the files that may be used by the system are held in the CATALOGUE subfile which is maintained by the data base administrator (6.3). The COBOL generating system

Figure 6.4 COBOL report program generating system input summary



carries on a dialogue with the user about relation names (file names) and passwords to determine which files are to be used by the generated COBOL program to produce the required report. From the information gathered during this dialogue a shorter version of the catalogue is written in the SUBMODEL subfile (Appendix V Section 2 and Figure 6.4). SUBMODEL contains details of only these files which contain problem data. Only fields to which the user has password access and which feature in the problem are described in SUBMODEL.

From the information in the SUBMODEL subfile all the COBOL file description statements can be generated without the user having to know anything about the physical or logical organisation of the data. The system designed can only generate COBOL statements for sequential access files on punched cards, paper tape, magnetic tape or disc. The files must be in ascending sequence and each record must have a unique key. The catalogue is, however, designed to hold descriptions of direct access files and those with keys in descending sequence. Processing to generate COBOL statements for such files can therefore be incorporated in the system design at a later date. The various restrictions on the system design are made necessary by the need to design a complete typical system (all features) and therefore no one feature can be followed in every aspect.

The two main usage forms common to all COBOL dialects are DISPLAY and COMPUTATIONAL, although there are frequently other usages which are machine dependent. In the initial system design all fields described in the catalogue are assumed to have DISPLAY usage. Only numeric fields can be used in arithmetic operations, but sequence key fields may be either numeric or alphanumeric.

6.4.2 Use of more than one input file

The data files to be used by the generated COBOL program were not specifically designed, created or maintained for use in a relational data base. They are therefore not necessarily in a suitably normalised form. In order to generate COBOL statements to control the reading of records and the matching of sequence keys when the report data is located on more than one file, some restrictions must be placed on the files which are acceptable. This problem is approached in three ways.

First, all non-key field names must be unique; only a key field name may be used in more than one file. This restriction is not imposed during catalogue maintenance (6.3), but is delayed until Stage 3 of the problem specifying dialogue (7.10), where it is automatically resolved. Duplicate non-key field names are made unique by appending characters to the name before it is displayed to the user (6.3.3). A user may notice that the names of domains in a relation change slightly from problem to problem.

In the second approach to the handling of non-normalised data files, the user may be made aware of restrictions, if the files he selects do not conform to certain key matching criteria. The system designed is capable of generating COBOL statements to match records in files which have the same sequence key fields, or whose sequence keys are an ordered subset of those in the file with the most keys, e.g.:

File number	Record format
1	KEY-A | KEY-B | KEY-C | KEY-D | non-key data fields
2	KEY-A | KEY-B | KEY-C | KEY-D | non-key data fields
3	KEY-B | KEY-C | non-key data fields
4	KEY-A | non-key data fields
5	KEY-D | non-key data fields
6	KEY-D | KEY-E | non-key data fields
7	KEY-E | non-key data fields

Records from any combination of files 2 to 5 may be matched with records from file 1. Records from files 6 and 7 cannot be matched with records from file 1 as it does not contain KEY-E.

If the keys in the files selected by the user do not satisfy the file matching criteria, he is advised, during Stage 3 of the problem specifying dialogue, that his relations cannot be joined. The run is terminated unless the user wishes to respecify the relations to be used.

The third way in which the use of more than one data file can affect the generation of the COBOL program is in the handling of unmatched key values. As the data files are created and maintained by other programs, their integrity cannot be guaranteed. In Stage 6 (7.3) the user is therefore invited to select one of three ways of handling unmatched keys:

1. The unmatched records are ignored.

2. A dummy matching record is created in which all the numeric non-key fields are zero and all the alphanumeric non-key fields are blank.

3. The execution of the COBOL program is terminated.

In all cases the user is given the option of having an error message displayed by the COBOL program. The error message will give the file name and key values together with a brief comment. The user may, if he wishes, specify the text of the comment which, by default, consists of the word 'MIS-MATCH'.

Up to nine input data files can be handled by the COBOL generating system and each file may have up to nine key fields. Each record is assumed to have a unique key value.

6.5 REPORT OUTPUT FACILITIES

In this section the overall design of the report itself is discussed. The generated COBOL program assigns the report output to a line printer file, where each non-blank line of the report occupies one record within the file. The form and content of the report file records are largely under the user's control as, during the problem specifying dialogue, he is offered a comprehensive range of facilities to enable him to design the layout of a printed page.

Details of the report output facilities offered to the user and the means by which they are provided are described in the paragraphs which follow. These facilities consist of choosing the report page dimensions and the selection and design of various categories of output which may be used to enhance the presentation of the report data, e.g. title, page heading etc. The specification of print line formats and the facilities for editing the output data are also described. The section concludes with a description of the facility to view a stylised sample page and the options available for redesigning it.

6.5.1 Page dimensions and categories of output

Although it is hoped ultimately to offer a choice between a narrow (72 characters) and a wide (120 characters) page the present implementation offers only a narrow page.

The format of the report lines and the number of lines per page are specified during a dialogue with the system. A page may contain between 40 and 99 lines with 60 lines being the default option. The report file records are specified under six categories:

1. Report title

Figure 6.5 Record category and field type summary

Record category \ Field type	Input File		Alphanumeric text literals	Page number Date Time	Temporary User		Subtotal	Total
	N-T	T			N-T	T		
Report title	×	×	✓	✓	×	×	×	×
Page heading	✓	✓	✓	✓	✓	✓	×	×
Sequence break heading	✓	✓	✓	×	✓	✓	×	×
Detail line(s)	✓	✓	✓	×	✓	✓	×	×
Subtotals	✓	×	✓	×	✓	×	✓	×
Totals	✓	×	✓	×	✓	×	×	✓

T= Totalling

N-T = Non-totalling

2. Page heading

3. Sequence break headings

4. Detail lines

5. Subtotals

6. Totals

The user is prompted to design the format of records in each of the categories applicable to his problem. Sequence break headings are offered only if two or more sequence keys are used in the input file(s). Subtotals and totals are offered only if the automatic totalling facility has been requested (6.6.3).

Each category may consist of more than one line of output and include blank lines. The user may also specify the number of blank lines which precede the first line of an output category. The format of each ouput line is described by the user in a similar way to that used in Filetab (2.3). Text in the form of an alphanumeric literal may also be included in any report line. Further details of the allocation of field specification characters are given in Section 6.5.8.

Figure 6.5 summarises the types of field which may appear in each category of output. Descriptions of the four right-most field types are given in Section 6.6.

Although the wide page option would make full use of the line printer facilities, the narrow page has a number of points to commend it, especially as the user's terminal may be restricted to 72 characters per line:

1. When the generated COBOL program is executed with real data the output may, by means of job control commands, be directed to a filestore file. Later it may be recovered and listed on the user's terminal without the wrap round/truncation problems which occur when an overlength line is output on a terminal.

2. The narrow page computer produced report can readily be

bound with manually produced material on A4 sized paper.

3. It is proposed to offer the user the opportunity of seeing a dummy report page after he has completed the design. The wide page would have to be displayed on the user's terminal in two parts, the left-hand side of the page and then the right-hand side side. Checking the page layout where the two parts meet would then present problems for the user.

A record description for each type of non-blank report line is generated in the WORKING-STORAGE section of the program in the form of a group field. The elementary fields of the group will depend on the contents of the print line specified. The WRITE ... FROM .... AFTER ADVANCING .... form is used in the Procedure division of the program to move the group contents to the report file record area and to control the line spacing when the report file is printed. The generated program uses Z-REPORT-FILE as the report file name and Z-OUTREC as its record area.

6.5.2 Report title

A title is optional, but if present it occupies the first page of the report. It consists of one or more lines some of which may be blank. The non-blank lines may include text, the page number, the date and the time. The page number of the title page is zero.

The user may specify on which line of the page the first line of the title is to appear. This must be a non-blank line and may not be more than half way down the page. By default the title will start at the line one quarter of the way down the page.

In the generated program the non-blank title line data descriptions are group fields called Z-TITLE-n, where n is the

number of the title line excluding intermediate blank lines, e.g. Z-TITLE-1, Z-TITLE-2 etc.

6.5.3 Page heading

A page heading is optional but if present it consists of one or more lines some of which may be blank. Any non-blank lines may include text, the date, the time, the page number, any temporary data item or any item from the currently retrieved set of data (i.e. the current tuple). Page numbering always starts at 1, even if the report title has been omitted. If a printed page heading is not required COBOL statements are generated which ensure that a skip to a new page (i.e. channel-1) is made as required without visible printing.

The user may specify on which line of the page the first line of the page heading is to appear. This must be a non-blank line and may not start more than 10 lines from the top of the page. By default the heading will start at line 1.

A page heading, either visible or invisible, is followed by the sequence break headings, if specified, for the current major to penultimate minor keys.

In the generated COBOL program the group data descriptions for the page heading lines are called Z-PAGE-n, where n is the number of the page heading line excluding intermediate blank lines, e.g. Z-PAGE-1, Z-PAGE-2 etc.

6.5.4 Sequence break headings

The user is offered the sequence break heading facility if his data files have two or more sequence key fields. A sequence break heading may be specified for each sequence key from major to penultimate minor and consist of one or more lines, some of which

may be blank. Text, temporary items or any item from the currently retrieved set of data may be included in any non-blank line.

The user may specify how many blank lines should appear between the previous line of output and the first line of the sequence break heading. The number of blank lines specified must be in the range 0 to 3, with 0 as the default value. The first line of the sequence break heading must be non-blank.

All the sequence break headings are printed at the top of each report page immediately after the page heading, if present. They are printed in major to penultimate minor key order. They may also appear lower down a report page when a sequence break in an item retrieved from a key field is detected. A sequence break at one key level will cause that key sequence break heading and also those at lower levels, if any, to be output. If, for example, 4 sequence keys are used in the input file, where level 1 is the major key, a sequence break at the level 2 key will cause the headings for key levels 2 and 3 to be output. Near the bottom of a report page sequence break headings are only output if there is also room to output at least one set of detail lines, otherwise a complete new page is taken.

In the generated program the group data descriptions for the sequence break heading lines are called Z-HEADm-n, where m is the sequence key level and n is the number of the non-blank line within that heading, e.g.:

Z-HEAD1-1, Z-HEAD1-2, ...	major key heading
Z-HEAD2-1, Z-HEAD2-2, ...	submajor key heading

6.5.5 Detail line(s)

For each retrieval from the input files, excluding those rejected by the selection conditions, one or more lines of output may be written on the report. A detail line may include text or any input field or temporary item. If more than one detail line is to be output for each retrieval, blank lines may be included.

The user may specify how many blank lines should appear between the previous line of output and the first line of detail, which must be non-blank. The number of blank lines specified must be in the range 0 to 3 with 0 as the default value.

The generated program data descriptions for detail lines are called Z-DETAIL-n, where n is the non-blank line number within the group of detail lines, e.g. Z-DETAIL-1, Z-DETAIL-2 for two lines of output per retrieval.

6.5.6 Subtotals

Subtotals output is offered only if the user has invoked the totalling facility and the input data files have two or more sequence key fields.

Subtotals are maintained for all totalling fields at all key levels except the minor key. If requested, subtotals are output when there is a sequence break in any non-minor key field. The subtotals are output in key level order from penultimate minor to major key. A sequence break in a key at an intermediate level will cause the subtotals for that key and all keys minor to it to be output. If, for example, 4 sequence keys are used in the input files, where level 1 is the major key, a sequence break in the level 2 key will cause the subtotal output at levels 3 and 2 to be printed. The level 3 output will precede that for level 2.

At each sequence key level, except the minor key, subtotal

output consists of one or more lines including blank lines. The first line must be non-blank and any non-blank line may contain text, non-totalling items, either temporary or from the last set of retrieved data, and the accumulated subtotal of any totalling item at that sequence key level.

At each subtotal level, the user may specify how many blank lines should appear between the previous line of output and the first line of the subtotal. The number of lines must be in the range 0 to 3 with a default value of zero.

Near the bottom of a report page a subtotal for any level is only output if there is room for all the lines of that level, otherwise it will appear on the next page of the report.

In the generated program the group data descriptions for the subtotal lines are called Z-SUBTOTALm-n, where m is the sequence key level and n is the number of the non-blank line within that subtotal, e.g.:

Z-SUBTOTAL1-1, Z-SUBTOTAL1-2, ... major key subtotal lines

Z-SUBTOTAL2-1, Z-SUBTOTAL2-2, ... submajor key subtotal lines

6.5.7 Totals

Totals output is offered only if the user has invoked the totalling facility. The totals output is written at the end of the report after the last detail record and subtotals records, if present.

Totals output consists of one or more lines and may include blank lines, but the first line must be non-blank. Each non-blank line may include text, non-totalling items, either temporary or from the last set of retrieved data, and the accumulated totals of any totalling items.

The user may specify how many blank lines should appear between the previous line of output and the first totals line.

This number must be in the range 0 to 3 and the default value is zero. If, near the bottom of a page, there is not enough room for all the total lines a new page will be used.

In the generated program the non-blank totals line data descriptions are group fields called Z-TOTAL-n, where n is the number of the total line excluding intermediate blank lines, e.g. Z-TOTAL-1, Z-TOTAL-2 etc.

6.5.8 Field specification

In order to design the layout of any category of report line the user is invited to select, from a given list, one alphabetic character for each field to be included in the report. A glossary mapping data field names to alphabetic label characters is thus created. When specifying the format of a report line the print positions to be occupied by a field are indicated by typing its label character in the desired positions (c.f. Filetab). Blank characters before and between fields are indicated by typing '#' characters. Blank characters at the right-hand end of a line needed not be typed.

Up to nineteen fields may be included in a report and their label characters may be selected from the following:

A E F G H I J K L N O Q T U V W X Y Z

The remaining characters of the alphabet are reserved for use by the editing facility (6.5.9) or to indicate where the date, time and page number fields are to print (6.6.1). Unlike Filetab, special types of field (e.g. key, transfer, totalling) are not denoted by special groups of characters. Instead the user is free to select a label character which may also serve as a mnemonic for a field name, e.g. N for NAME, A for ADDRESS.

The double quotation mark character (") is used to delimit

the text literal. It was chosen in order to avoid confusion with the single quotation mark character (') which is used as a literal delimiter by the macro processor.

If more print positions are allocated to an alphanumeric field than the field actually contains the data is left justified in the specified positions and unused positions are filled with blanks. If too few print positions are allocated to an alphanumeric field then the characters at the right-hand end are truncated.

Unless the editing feature (6.5.9) is in use, the decimal point in the output format of a numeric item is assumed to be after the right-most digit. Leading zeros are replaced by blanks up to but not including the zero before the implied decimal point. The decimal point location in the field to be output is aligned with that implied in the output format. If more print positions are allocated than the field requires, the unused positions are filled with blanks. If too few print positions are allocated the high order digits will be truncated.

The names of the data fields are displayed on the user's terminal one at a time. As each field name is displayed the user indicates that it appears in the report by typing the character he has chosen as its label. The default reply, made by pressing only the 'Accept' key, indicates that the currently displayed field does not appear in the report.

The date and time from the additional data items (6.6.1) each occupy 8 characters and the user must indicate their print positions by typing the character strings DD/MM/YY and HH/MM/SS respectively. The page number, also an additional data item, occupies four characters and the string PPPP is used in the required print positions. Leading zeros in the page count will be suppressed when the value is printed.

In order to distinguish text from field label characters in a line format specification the text is enclosed in quotation marks. The quotation marks are replaced by blank characters when the line is printed.

Although not implementated, it would be appropriate and desirable to provide the user with the facility which enables him to inspect his glossary of labels. In response to one or more label characters he could be given the name of the data assigned to that character. Details of the label character, field name and field type (alphanumeric or numeric) are, however, written to the LABELTABLE subfile (7.15). This subfile is used during the validation of the line format specifications for the various categories of report record.

The model problem dialogue for Stage 8 (Appendix IX Section 8) contains examples of the assignment of label characters.

6.5.9 Editing

The editing facilities have been chosen to provide a balanced selection of those available in COBOL. Because the field editing requirements are entered during the specification of print line formats, the edit characters are present in the field label character strings which denote the print positions of the field. Each field label character string has to be translated into a COBOL data description with the appropriate PICTURE. The editing facilities for any field depend on its type, ie alphanumeric or numeric.

In order to help the casual user understand the editing facility it is proposed to allow some experimental editing before the line formats are entered or the generated program is run with real data (6.5.10). By means of the 'help' facility the user may also 'break out' of designing the report to do some more editing

experiments (6.2.3).

Alphanumeric field editing:

Two insertion characters are available for use with alphanumeric fields, they are the characters B and 0.

Insertion characters may be inserted anywhere in the string of label characters defining the print positions of an alphanumeric field. The 0 character will print as a zero in the output line, but the B character will be replaced by a blank character.

Numeric field editing:

The following characters are used to specify editing requirements of numeric fields:

£ $ * + - , . CR DB B 0

The function of each of the above symbols and the permitted combinations are set out below.

£ and $ are currency symbols which, if used, must appear once only at the beginning of the field format specification. The selected currency symbol will print in front of the most significant digit of the edited result. A currency symbol may be preceded only by a + or - character.

* is the cheque protection symbol. If used, this character must appear at the beginning of a field format specification. It will cause the unused high order print positions of the edited result to be filled with * characters. Only the + or - charaters may precede it.

+ and - signs. A + or - sign may appear as the first character of a field format specification. If the sign of the data being edited is the same as the sign character then the sign character will print. If the data has the opposite sign to that in the edit format then a + sign will be replaced by a - and

a - will be replaced by a blank in the edited result. The sign character, if printed, will appear to the left of the most significant digit of the item providing that a currency or cheque protect symbol has not been used. If the currency or cheque protect symbols have been specified the sign will remain in the first position of the field.

CR and DB are report signs. Either CR or DB may appear in the two right-most positions of the field format. If the data being edited is negative then the report sign characters will print in the specified positions. If the data is positive then the two print positions occupied by the report signs will be set to blanks.

B 0 , and . are insertion characters which, with the exception of the B character, will print in the designated positions of the edited field. The B character will be replaced by a blank. The decimal point may not appear in the right-most print position of an edited field and must be preceded by at least one label character. The implied decimal point in the data is aligned with the decimal point in the print edit format. If insufficient print positions have been allocated on either side of the decimal point truncation will occur at the both ends of the edited result. If more print positions to the right of the decimal point have been allocated than are required, they will be filled with zeros. Insertion characters to the left of the high order digit are replaced by blanks.

6.5.10 Experimental editing

Although the text explaining the field editing facilities to the user contains examples, the editing rules are difficult to grasp at the first attempt. To alleviate this difficulty it is proposed to offer the user the opportunity to experiment with the

editing facilities before he designs his report format. The user is invited to type a field output format, either alphanumeric or numeric, using a valid label character and edit symbols. This is validated and, if found acceptable, the user is invited to enter a value to be edited. The edited result is then displayed on the user's terminal (5.6). This process may be repeated until the user is satisfied that he can design the field editing formats which will give the output he requires.

Figure 6.6 illustrates the use of the editing symbols and shows their relation to the COBOL edit PICTURE which would appear in the generated program.

Figure 6.6 Editing examples

Label character	Field type N=numeric A=alphanumeric	Edit format	COBOL PICTURE	Value of data to be edited	Edited result
K	A	KBKKKKOKK	XBXXXXOXX	CNUT4DE	C NUT4ODE
A	N	-£AAA,000	-£££9,000	-23	- £23,000
E	N	*EEEEECR	*****9CR	4795	**4795
F	N	FF,FFF.FF	ZZ,ZZ9.99	1347.63	1,347.63
G	N	GGBGGBGG	ZZBZZBZ9	27641	2 76 41

6.5.11 Sample page viewing

Because the formats for the various categories of output are entered during the course of a dialogue it is not easy to get an overall impression of the report page. Especially as the formats for the various categories of output are not entered in the same order that they would appear in the report, e.g. detail lines are specified before the page heading.

It is therefore proposed to offer the user the chance to see a sample of the report page layout before the generated program executes on real data. The user may then respecify the format for any category of output which is not to his liking and view again the sample report.

The ouput sample will consist of a title page, if present, and a report page containing one example of each of the output categories requested by the user except the detail category. This latter category will be repeated several times to give the impression of a full page. The output categories appear in their natural order, i.e. page heading, sequence break headings, details, subtotals and totals. The page layout display will enable the user to check the vertical alignment of heading, detail, subtotal and total data.

The lines in each category will be spaced according to the user's requirements and consist of the line format specifications as entered by the user with two modifications. All visible space characters (#) and all text literal delimiters (") will be replaced by blanks.

An example of the page layout display is included in the model problem dialogue for Stage 17 (Appendix IX Section 17).

6.6 DATA MANIPULATION FACILITIES

In this section the additional processing features provided by the system for the manipulation of data are described and their means of provision are oulined.

These features include the provision of additional data items by the system, the creation of temporary items by the user, the automatic totalling of user selected numeric data items and the provision of own code statements for manipulating data items. The facilities for extending the own code statements to access totals and subtotals are described. The section concludes by describing the condition specification facilities which permit the selection of report data and/or the conditional execution of own code processing.

6.6.1 Additional data items

In addition to the data items from the user's data base domains three others are available for inclusion in his printed report. They are the date and time at which the generated COBOL program begins to execute and the count of pages in the report. The user is introduced to these items in Stage 11 of the system (7.19) and their field specification strings are described in paragraph 6.5.8.

The COBOL program obtains the date and time from the operating system executive by means of ACCEPT statements in the initialisation section of the Procedure division. The ACCEPT statements refer to data items in the SPECIAL-NAMES paragraph of the CONFIGURATION section. In the WORKING-STORAGE section the date and time are stored in items ZDATE and ZTIME which are part of the Z-TUPLE group. The generated COBOL program therefore contains the following statements:

```
CONFIGURATION SECTION.
     :
SPECIAL-NAMES.
     *DATE IS Z-DATE *TIME IS Z-TIME.
     :
DATA DIVISION.
     :
WORKING-STORAGE SECTION.
     :
01   Z-TUPLE.
     02 ZDATE PICTURE X(8).
     02 ZTIME PICTURE X(8).
     :
PROCEDURE DIVISION.
Z-INITIAL SECTION.
Z-PARA-1.
     :
     ACCEPT ZDATE IN Z-TUPLE FROM Z-DATE.
     ACCEPT ZTIME IN Z-TUPLE FROM Z-TIME.
     :
     :
```

The page count is stored in the Z-PAGE-COUNT data item which is also part of the Z-TUPLE group. This variable is updated during the execution of the statements generated to control the taking of a new page (Appendix VIII Section 23).

6.6.2 Temporary data items

The system includes provision for the user to create temporary data items. These exist only in the WORKING-STORAGE section of the generated COBOL program, but may be included in the printed report. Their contents may be manipulated using the own code facility (6.6.4) and they fall into three types - numeric, alphanumeric and group. This facility is offered in Stage 5 of the system (7.12) and the model problem dialogue (Appendix IX Section 17) contains an example of its use.

Numeric items:

The system explains to the user how temporary numeric items may be needed to store results and intermediate results arising

from the own code facility, e.g. a quotient or a remainder. In a dialogue with the user the system asks for a description of each temporary numeric item by prompting him to enter details of the item name, size, decimal point location and, if desired, the initial value. By default the initial value is set to zero. In the generated COBOL program the item is assigned COMPUTATIONAL usage.

The automatic totalling facility (6.6.3) is also available for temporary numeric items.

Alphanumeric items:

The user is invited to create temporary alphanumeric items which may be used with the own code facility. The system prompts the user to describe the alphanumeric item by asking for details of its name, size and, if desired, the initial value. By default the initial value is set to be blank when the item is described in the WORKING-STORAGE section of the COBOL program.

Group items:

Group items may be formed by concatenating data from two or more other items, for example, three data items containing respectively details of street, town and postcode may be concatenated into a single group item called, say, ADDRESS:

```
02  ADDRESS.
    03  STREET PICTURE X(20).
    03  TOWN PICTURE X(20).
    03  POSTCODE PICTURE X(10).
```

The items to be concatenated may be either numeric or alphanumeric and come from any domain or temporary item. In the dialogue they are referred to as compound domains. The system carries out a dialogue with the user and prompts him to enter the names of the items to be concatenated. Group items are assumed to

be alphanumeric and their size is the sum of the sizes of the concatenated fields. When the user has finished specifying the names of fields to be concatenated, the system prints out a message to tell the user the size of the items in the compound domain, i.e. the group item.

In the generated COBOL program, the MOVE statements which set up the group are executed after the file records have been matched and before any own code processing.

6.6.3 Totalling facility

The system provides for the automatic totalling of data in a numeric field of an input file or in a temporary numeric item should the user so desire. The accumulated subtotals and totals (6.5.6 and 6.5.7) are available for inclusion in the output report and may be used in own code processing (6.6.4).

If totalling is requested by the user, the system generates the data description statements in the WORKING-STORAGE section ready for the totals to be stored. Control totals are generated for each requested item at each sequence key control level except the minor key. A control total is also generated for the final totals of the run. When, for example, the input file(s) have three sequence keys and automatic totalling is required for numeric items COST and QUANTITY, the following statements would be generated:

```
01  Z-CONTROL-TOTALS.
    02 Z-LEVEL-2.                          Submajor key
       03 COST PICTURE ...                 subtotals
       03 QUANTITY PICTURE ...
    02 Z-LEVEL-1.                          Major key
       03 COST PICTURE ...                 subtotals
       03 QUANTITY PICTURE ...
    02 Z-LEVEL-0.                          Final
       03 COST PICTURE ...                 totals
       03 QUANTITY PICTURE ...
```

All the items are given an initial value of zero and are described as COMPUTATIONAL. The PICTURE description will depend on the location of the decimal point in the field, but will always be signed and have the maximum size of 18 digits.

The use of the same data names at each control level enables the system to make use of the ADD CORRESPONDING statement in the Procedure division for the accumulation of totals, e.g.:

```
Z-PARA-ADD.
    ADD CORRESPONDING Z-TUPLE TO Z-LEVEL-2.
```

The ADD statement is executed after any own code processing associated with the data retrieval and prior to the setting up of a detail line for the report.

The ADD CORRESPONDING statement is also used to add the totals of one level to the totals of the next level when a sequence change in a key field is detected. The SUBTRACT CORRESPONDING statement is then used to reinitialise the control totals at that level, e.g.:

```
ADD CORRESPONDING Z-LEVEL-2 TO Z-LEVEL-1.
SUBTRACT CORRESPONDING Z-LEVEL-2 FROM Z-LEVEL 2.
```

The totalling facility is offered to the user in Stages 4 and 5 of the system (7.11 and 7.12). The model problem dialogue for these stages contains examples of this facility (Appendix IX Sections 4 and 5).

6.6.4 Own code processing

Own code processing is optional and supplements the basic data movement and totalling features provided automatically in the generated program.

Own code processing allows the user to specify his own calculations and/or data movements for insertion at the following points in the generated program:

1. After the files have been opened but before any data is

read.

2. Immediately after a data retrieval, i.e. after a set of matched records from the input data files have been read.

3. Immediately after a sequence break in any specified key, except the minor key, is detected.

4. Prior to printing any category of output lines present in the program, i.e. title, page heading, sequence break heading, detail, subtotal or total lines.

Five statements are provided whereby the user can express his own processing requirements. Four statements are for arithmetic purposes and one is for data transfer. Each statement permits one operation and is expressed in English or COBOL type language. By means of instructional text, with examples, the system describes the use of the own code statements. In addition, if the user has availed himself of the totalling facility, he is told how to access the subtotals at any key level or the final totals.

Any number of own code statements may be entered for inclusion at the permitted places in the generated COBOL program. The user is prompted to enter one own code statement at a time. After validation each statement is translated into a syntactically correct COBOL statement by the insertion of data-name qualifiers and punctuation. Before each own code statement the user may specify what conditions, if any, must be satisfied before it is obeyed (6.6.6).

Arithmetic statements:

There is one statement for each of the arithmetic operators (addition, subtraction, multiplication and division), and each contains an operator and three operands. The third operand specifies where the result of operating on the first two operands

is to be stored. Each statement is entered by the user as a one line response and takes one of the following forms:

ADD operand-1, operand-2 GIVING operand-3

SUBTRACT operand-1 FROM operand-2 GIVING operand-3

MULTIPLY operand-1 BY operand-2 GIVING operand-3

DIVIDE operand-1 BY operand-2 GIVING operand-3

When the DIVIDE statement is used, the user is asked if he wishes to save the resulting remainder and, if so, to specify the name of the item where it is to be stored. This must be of numeric type and may be a domain or temporary item.

Operand-3 may be the name of any temporary item or the name of a domain to which the item being calculated belongs.

Operand-1 and operand-2 may be either a numeric literal, the name of a temporary item or the name of a domain to which the item being calculated belongs, e.g.:

MULTIPLY QUANTITY BY PRICE GIVING COST

DIVIDE PENCE BY 100 GIVING POUNDS

Data transfer statement:

One data transfer statement is available for own code use and it takes the following form:

MOVE operand-1 TO operand-2

Operand-2 is the receiving item and may be the name of a temporary item or the name of a domain to which the item receiving the data belongs.

Operand-1 is the source item and may be a literal, a temporary item or the name of the domain to which the item being moved belongs. Operand-1 must be of the same type, i.e. numeric or alphanumeric, as operand-2.

When alphanumeric data is moved, the characters from the source item are transferred to the corresponding positions of the

receiving item, starting with the left-most. If the receiving item is the longer item then the excess characters in the receiving item are filled with blanks.

When numeric data is moved, the decimal points in the source item and receiving item are aligned. If there are fewer characters before or after the implied decimal point in the receiving item, then the excess characters in the receiving item are set to zero.

The above rules for data movement are in line with those for the COBOL MOVE verb with the added restriction that both operands must be of the same type.

The following are examples of own code MOVE statements:

```
MOVE 1.65 TO UNIT-PRICE
MOVE QTY-ON-ORDER TO QTY-ON-HAND
MOVE "NOT MARRIED" TO SPOUSE-NAME
```

6.6.5 Access to subtotals and totals

Access to subtotals and totals data by own code statements is only available when the totalling facility has been invoked by the user. The user may have access to the subtotals applicable at any specific key sequence break (except the minor key) or the final totals after all the data records have been read and processed.

In order to distinguish the subtotal or total of items from a given field (domain or temporary item) from the value of the previous item in that field, the operand name is prefixed by an '*' character in the own code statement, e.g.:

```
DIVIDE *STOCK-VALUE BY *QUANTITY GIVING AVERAGE-PRICE
```

The use of the '*' character is not permitted in operand-3 of an arithmetic statement nor in operand-2 of a MOVE statement.

The model problem dialogue for Stage 18 contains an example of this facility (Appendix IX Section18).

6.6.6 Condition specification

As the user may only wish to include in the printed report data from some of his tuples, or only to execute own code statements under certain conditions, it is necessary to provide him with the means of specifying such conditions.

Condition specification is described to the user prior to the report data selection dialogue. The user may optionally remind himself about condition specification prior to the entry of his own code processing requirements.

Conditions may be simple or compound. A compound condition is made up of several simple conditions linked by the conjunctions AND or OR. The system dialogue prompts the user to enter each simple condition as a one line response and, in the case of compound conditions, to select the appropriate linking conjunction. As parentheses are not used to indicate the hierachy of evaluation in compound conditions (5.5), the user is reminded that after an OR conjunction it is necessary to repeat any simple condition which still applies. Each simple condition is validated and translated in to a syntactically correct COBOL IF sentence by the insertion of data name qualifiers and the replacement of operators by their COBOL equivalent.

Each simple condition consists of three parts - two operands separated by an operator:

operand-1 operator operand-2

Operand-1 is the name of a temporary item or the name of the domain (field) to which the item being tested belongs.

Operand-2 specifies with what the first operand must be compared. It may be the name of a temporary item, a literal or

the name of the domain to which the compared item belongs. The text of an alphanumeric literal must be delimited by quotation marks (").

The following four-character operators are available:

.EQ. (equal to)
.LT. (less than)
.LE. (less than or equal to)
.GT. (greater than)
.GE. (greater than or equal to)
.NE. (not equal)

Any of the above operators may be negated by including the word NOT immediately after the first full stop, e.g. .NOT GT. The COBOL equivalents of the above operators are shown below:

Relational operator	COBOL equivalent
.EQ.	EQUAL TO
.LT	LESS THAN
.LE.	NOT GREATER THAN
.GT.	GREATER THAN
.GE.	NOT LESS THAN
.NE.	NOT EQUAL TO
.NOT EQ.	NOT EQUAL TO
.NOT LT.	NOT LESS THAN
.NOT LE.	GREATER THAN
.NOT GT.	NOT GREATER THAN
.NOT GE.	LESS THAN
.NOT NE.	EQUAL TO

Operand-1 and operand-2 must be of the same type, either both numeric or both alphanumeric. This is more restrictive than COBOL which permits numeric DISPLAY fields to be compared with alphanumeric fields. The restriction is imposed because numeric DISPLAY fields in the data file records are held as COMPUTATIONAL items in the Z-TUPLE group of the WORKING-STORAGE section of the generated program, and so occupy a different amount of storage space from the original field.

Stage 7 of the model problem dialogue contains an example of condition specification (Appendix IX Section 7).

6.7 SUMMARY AND APPRAISAL

The facilities of the COBOL report program generating system as proposed in the preceding sections of this chapter provide a basic but complete tool, which allows the user considerable flexibility in selecting and presenting report data. The relational view of the data and the computer dominated dialogue, with its instructional text and 'help' facility, enable the casual user to specify his report requirements without needing to understand the physical organisation of the data used.

The catalogue, containing the data base file descriptions and maintained by the data base administrator, enables access to sensitive data to be controlled. It also permits different users to have different views of the data appropriate to the problem the they wish to solve. The 'flat' files described in the catalogue need not have been created exclusively for the system, but must satisfy certain criteria with regard to their organisation and contents. There is, however, provision in the design of the catalogue for the future relaxation of these criteria to enable a wider range of file types to be acceptable.

The system design is influenced by the structure and facilities of the PG/2 macro processor, but makes good utilisation of the host computer's resources by relegating non-dialogue parts of the system to background batch mode.

By the provision of new macros a number of extensions to the COBOL report generating system are possible. These would both make the present system easier to use for the casual user and provide new facilities. The latter could include the provision of

model data subfiles to enable the user to check the semantics of his own code processing and provide a more realistic sample page viewing facility. The model data subfiles would be provided by the data base administrator through an extended catalogue processor.

There is also potential for extending the COBOL generating system to cover other information processing problems to include, for example, file updating.

With the increase in the number of computers in use, especially micro computers, more non-computer specialists will be called upon to use them. Research into the development of software for the generation of programs can contribute towards helping such users make efficient use of computer resources.

CHAPTER 7

IMPLEMENTATION OF SELECTED FEATURES

7.1 INTRODUCTION

The purpose of the practical work was threefold:

1. To validate aspects of the ideas presented in Chapters 5 and 6 for a dialogue based COBOL report program generator.

2. To explore the problems with dialogue creation and program generation using the PG/2 macro processor.

3. To establish the validity of the COBOL programs generated by such a system.

The volume of coding and programming effort required for the complete development of the COBOL generating system is large: probably of the same order as that required for the development of a compiler. It was not therefore possible to implement all the facilities planned for the three phases of the system.

The complete development of the first phase (the macros for maintaining the catalogue of data base file descriptions) was of prime importance, for without the catalogue there are no file descriptions on which to base the other facilities.

The design of the second and third phases of the system (the problem specifying macros and the macros for generating the complete program) is closely linked, for the former gathers the information and saves it in a form suitable for use by the latter. The problem specifying dialogue, validation of user's responses, subfile usage and formats and the macro processing for these two phases was planned in some detail, although the facilities for the wide page and default formatting facilities were omitted. Because the macros for one stage of the problem specifying dialogue make use of the information gathered in the previous stages it was most convenient to begin their development in the order in which they

are executed. The HELP macro and the macros for the first eight stages of the problem specifying dialogue were coded, although the development of macros beyond STAGE3 is incomplete.

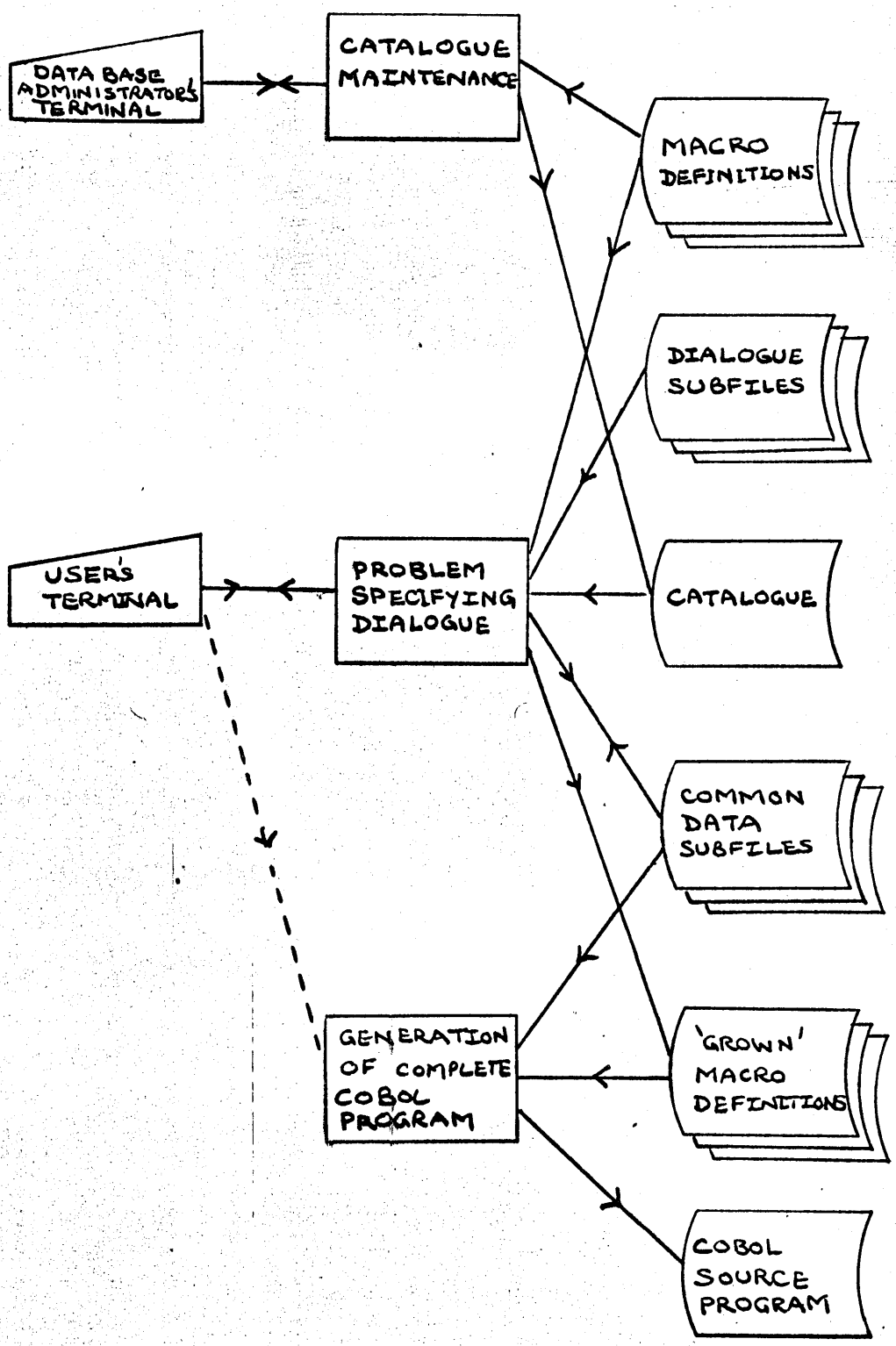
The validity of the COBOL programs generated by the system is illustrated in Appendix X by a hand coded program to solve the problem described in Section 5.9. All stages of the program generation were carried out manually and the fabricated program compiled and executed using a specially created data base. Macro development and COBOL program testing were carried out on a teletype terminal accoustically coupled via the public telephone network to a remote ICL 1900 series computer.

The following sections of this chapter describe the implementation of the system and cover the topics shown below:

1. Outline structure of the system.
2. The use of subfiles.
3. Descriptions of the catalogue maintenance macros.
4. The use of routines within macros.
5. Descriptions of the macros for the first nine stages of the problem specifying dialogue.
6. The general strategy for processing report output format specifications.
7. Descriptions of the macros for the remaining nine stages of the problem specifying dialogue.
8. The HELP macro.
9. Generation of the complete COBOL program.

The sections are supported by material in Appendices V to X which provide additional information on subfile formats, macro processing, user response validation, COBOL generation details, samples of the problem specifying dialogue and generated COBOL program. Listings of all the macros which were coded are included in the separate folder. The chapter concludes with a summary and

Figure 7.1 Outline structure of the COBOL report program generator



appraisal.

7.2 OUTLINE STRUCTURE

The organisation of the COBOL report program generator, which runs under the PG/2 macro processor, falls naturally into three phases:

1. Catalogue maintenance.
2. Problem specifying dialogue.
3. Generation of the complete COBOL program.

The outline structure is illustrated in Figure 7.1 and brief descriptions are given in the following subsections.

The first phase is used exclusively by the data base administrator for setting up and maintaining the catalogue of data base file descriptions.

The second phase requires interaction with the user throughout its execution, while the third phase only requires the user to initiate its execution which takes place in background mode.

The second and third phases are linked by PG/2 macro processor subfiles which are used extensively for the following purposes:

1. Catalogue of file descriptions.
2. Macro definitions.
3. Dialogue.
4. Common data.
5. 'Grown' macro definitions.
6. COBOL source program.

Further details of subfile usage are given in Section 7.3.

7.2.1 Catalogue maintenance

As described in Sections 6.3.4 and 6.3.5, the data base administrator is initially provided with macro definitions for the following tasks:

1. Creating an empty catalogue.
2. Changing the catalogue password.
3. Inserting or deleting a file description.

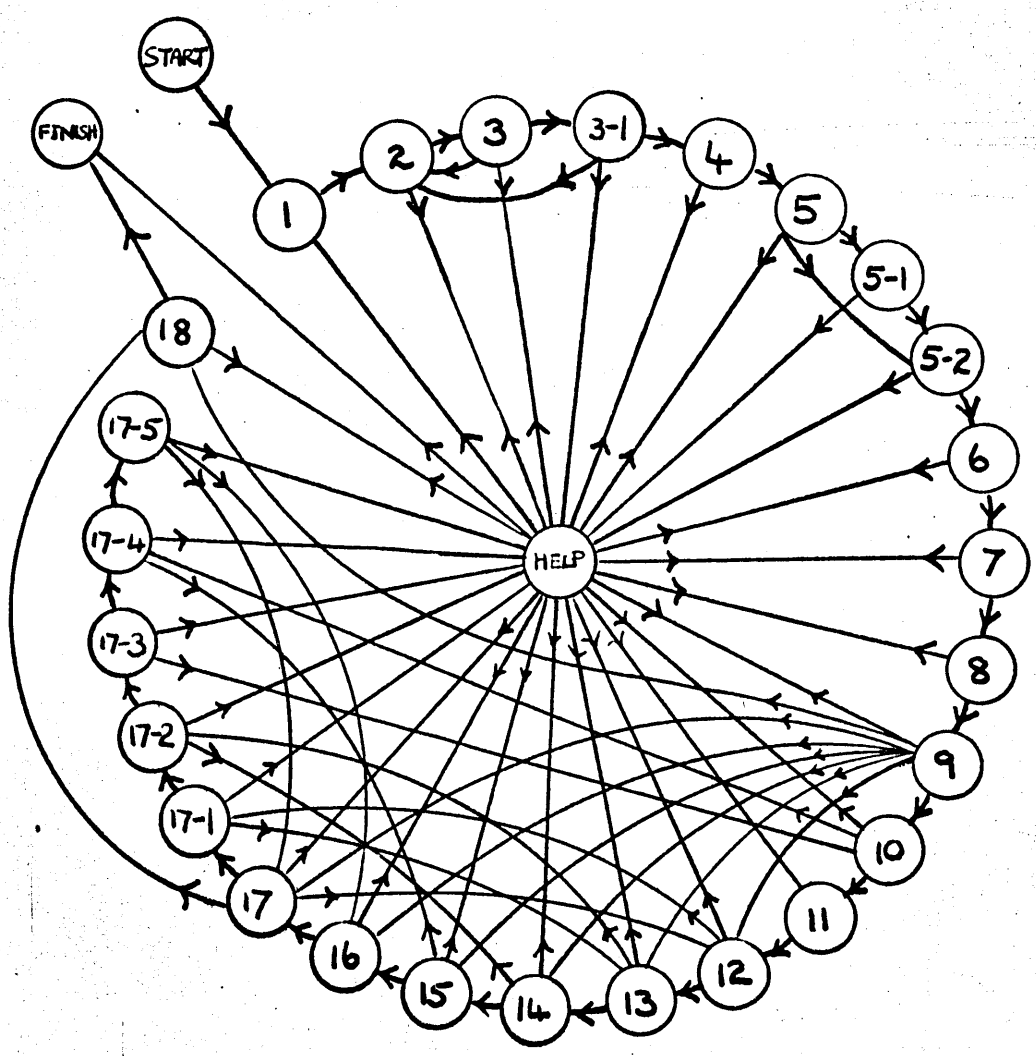
The first two tasks are carried out by the macros CREATE and PASSCHANGE respectively. The third task is more complicated and uses four chained macros - LIBRARIAN, LIBPRELIM, LIBDELETE and LIBADD. The implementation details for these macros are given in Sections 7.6.1 to 7.6.4.

7.2.2 Problem specifying dialogue

The problem specifying dialogue is conveniently carried out in eighteen stages (6.2.2), each covering an identifiable topic and consisting of one or more macro definitions. Each macro definition automatically chains to the next. When the 'help' facility is invoked the dialogue may be resumed at the start of any of the preceding stages. Figure 7.2 illustrates the macro linkages.

The information provided by the user during the course of the dialogue is processed for use in two types of subfile. Some information is used to generate COBOL and macro-time statements which are stored in the bodies of the 'grown' macro definitions. Other information is recorded, sometimes in abbreviated form, in the common data subfiles.

Figure 7.2 Macro linkages for the stages of the problem specifying dialogue



The normal route is by the peripheral path.

7.2.3 Generation of the complete COBOL program

The complete COBOL program is synthesised by macros which generate COBOL statements from the information in the common data subfiles and make nested calls to the 'grown' macros. In this way the COBOL statements in the bodies of the 'grown' macros are regenerated to appear in their correct positions within the complete program. Further details are given in Section 7.28.

7.3 SUBFILE USAGE

The arrangement of subfiles within mainfiles is outlined and brief descriptions of each type of subfile are given in the following order:

1. Catalogue of file descriptions.
2. Macro definitions.
3. Dialogue subfiles.
4. 'Grown' macro definitions.
5. Common data subfiles.
6. COBOL source program.

The section concludes with a description of how common data subfiles are used.

Section 30 of Appendix VII contains a summary of the subfiles used by the generating system and gives details of their initialisation.

Because a limited number of subfiles may be located on a PG/2 macro processor mainfile, several mainfiles are used (4.7.3). The general strategy adopted in each macro definition is to assume that the mainfile on which the macro is located is the current mainfile. Thus any macro which needs to reference a subfile on a different mainfile must temporarily change the mainfile name and restore the original mainfile name after use. An example of this

strategy occurs in the STAGE7 macro, a listing of which is included in the separate folder (Item 26).

7.3.1 Catalogue of file descriptions

The catalogue of file descriptions is located on the CATALOGUE subfile and contains details of all the files in the data base. The subfile is maintained by the data base administrator and access is protected by a multilevel password system. Detailed descriptions of the format, creation and maintenance of the CATALOGUE subfile are given in Sections 6.3, 7.4, 7.5 and 7.6.

7.3.2 Macro definitions

Each stage of the problem specifying dialogue consists of one or more macro definitions. The first macro of each stage is called STAGEn, where n takes the values from 1 to 18. When a stage requires more than one macro definition, either from consideration of size or convenience, the names of the other macros take the form STAGEn-m, where m takes the values 1,2 etc. For example, Stage 3 consists of the macros STAGE3 and STAGE3-1. Each macro automatically chains to the next macro, but only the first macro in a multimacro stage is a check point for restarting the dialogue after a request for help (Figure 7.2). There is also the special purpose HELP macro which may be called at various points in the processing chain.

All macro definitions are stored in subfiles which have the same name as the macro.

7.3.3 Dialogue subfiles

These subfiles are of two types:

1. Instructional text
2. Model problem text

The instructional text which introduces each stage of the problem specification is stored in a series of subfiles, one for each stage. There is also a subfile of instructional text for the HELP macro. The use of several subfiles enables the text for one stage to be changed independently of the other stages. The use of text subfiles helps to reduce the core storage demands made by the various macros on the internal stacks and tables of the PG/2 macro processor. The instructional text subfiles are called DIAL1 to DIAL18 for the problem specifying stages and DIALHELP for the HELP macro.

There is one model problem text subfile for each stage of the problem specifying dialogue and the subfiles are called MODEL1 to MODEL18. Each subfile contains a copy of the instructional text, prompts and responses which would appear on the user's terminal at the corresponding stage during the specification of the model problem. Details of the model problem are given in Section 5.9.

In both types of dialogue subfile each line of text occupies one subfile record which may contain up to 72 characters. The contents of the appropriate text subfile is read and written out on the user's terminal, record by record, during the macros of each stage or during the execution of the HELP macro. The macro-time statements used in each macro to output the contents of a text subfile are similar. An example may be seen in the STAGE1 macro, a listing of which is included in the separate folder (Item 17).

7.3.4 'Grown' macro definitions

The statements for the 'grown' macro definitions are generated and filed in the appropriate subfile during the execution of the problem specifying stages. Each macro definition which is 'grown' is stored in a subfile of the same name as the macro and takes the form:

```
%DEF  macro-name
      Generated COBOL statements
      and/or
      generated macro-time statements.
%END
```

The body of the macro contains COBOL and/or macro-time statements which depend on the user's problem.

The generated statements are filed in the appropriate subfile using the SAVE macro-time statement. Where statements for more than one macro definition are generated within a stage, it is necessary to file the statements immediately after they are generated. If only one macro is being 'grown', the generated statements may all be filed by one SAVE macro-time statement towards the end of the stage.

The macros 'grown' during the problem specifying dialogue are executed by means of nested calls when the complete COBOL program is generated.

7.3.5 Common data subfiles

The information gathered during the problem specifying dialogue is often stored in common data subfiles. The common data subfile is referenced either in a later stage of the dialogue or during the generation of the complete COBOL program.

Common data subfiles are used because the volume of

information gathered during the dialogue greatly exceeds that which could be stored in the local, global and string variables of the PG/2 macro processor.

The format details of all the common data subfiles are given in Appendix V in the order in which they are used. An outline of how they are used is given in Section 7.3.7.

7.3.6 COBOL source program

When the complete COBOL program is synthesised the COBOL subfile is used to store the generated statements in their correct program sequence.

7.3.7 Use of common data subfiles

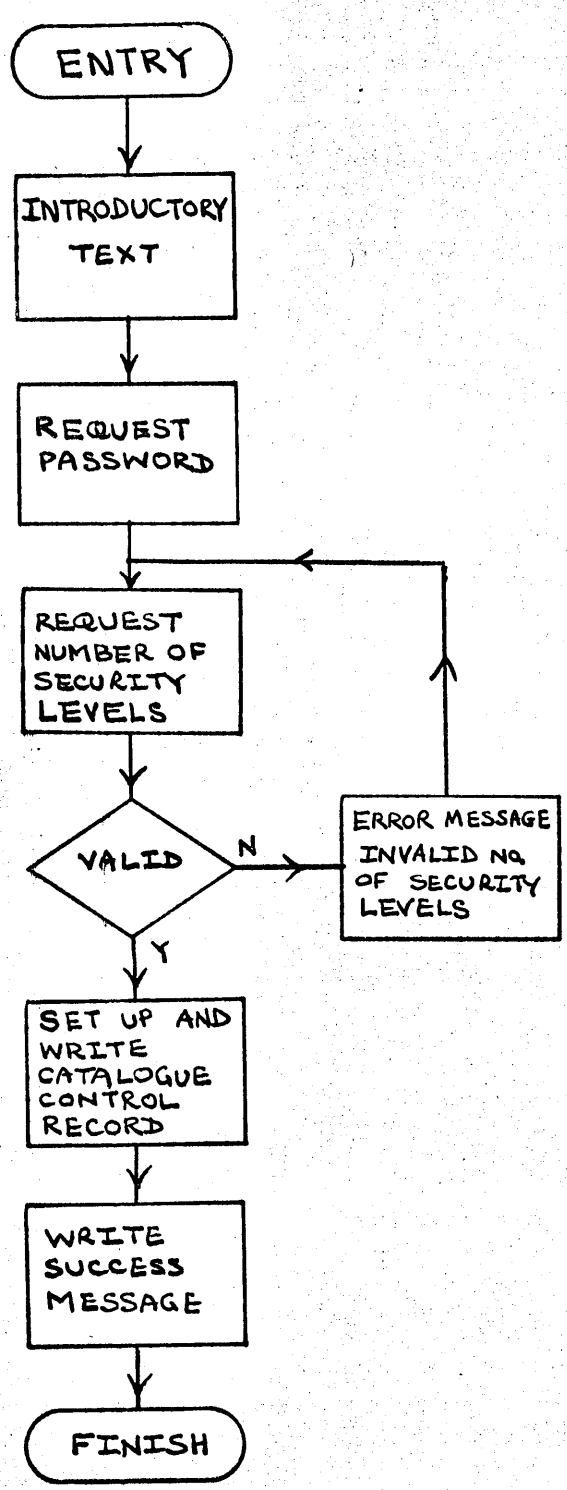
Throughout the stages of the problem specifying dialogue there is a progressive refinement of the information about the user's data base. Only information relevant to the current problem is retained so that subfile search time is mimimised.

The catalogue of file descriptions in the CATALOGUE subfile contains details about all the data files and all fields within the records of those files in the data base. The SUBMODEL common data subfile, although similar in format to the CATALOGUE subfile, contains details of only those files and fields to which the user has password access and which are required for the generation of the COBOL program (7,10).

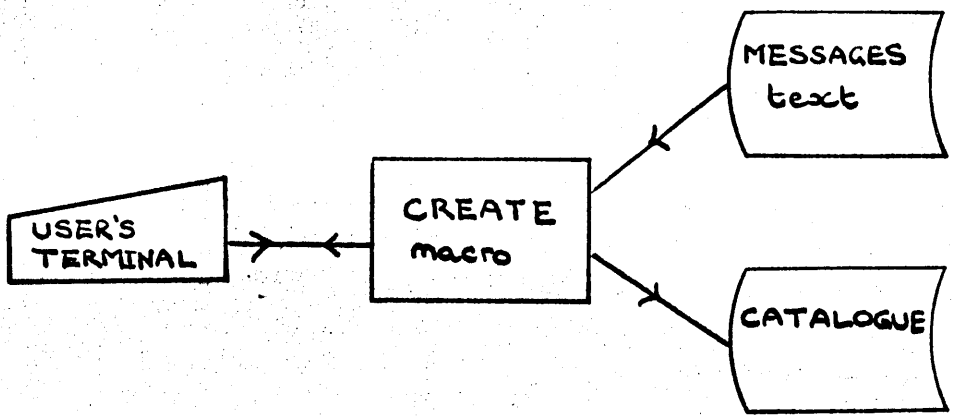
As the stages of the problem specifying dialogue are checkpointable a subfile written in one stage cannot be modified in a later stage. To do so would jeopardize the 'help' facility which allows the user to resume processing at an earlier stage in order to change his mind about a previous decision. Instead, data from one common data subfile must be copied to another subfile

and the latter updated. For example, the domain dictionary is first written in the DOMAINDICT subfile during Stage3. In Stage 4 the dictionary is refined and recorded in the DOMAINLIST subfile. When, in Stage 5, the dictionary is extended to include temporary and compound domains, the DOMAININDEX subfile is used.

Figure 7.3 Outline processing for the CREATE macro



7.4 CREATE AN EMPTY CATALOGUE



The CREATE macro creates the control record for an empty catalogue. The macro carries out a short dialogue with the data base administrator to gather details about the catalogue password and the number of security levels by which the data files to be described therein will be protected (Figure 7.3). As the data base administrator is assumed to be an experienced user the dialogue does not adopt a tutorial approach.

The text for the introductory description and the requests for information are stored in the MESSAGES subfile and are output on the user's terminal as required.

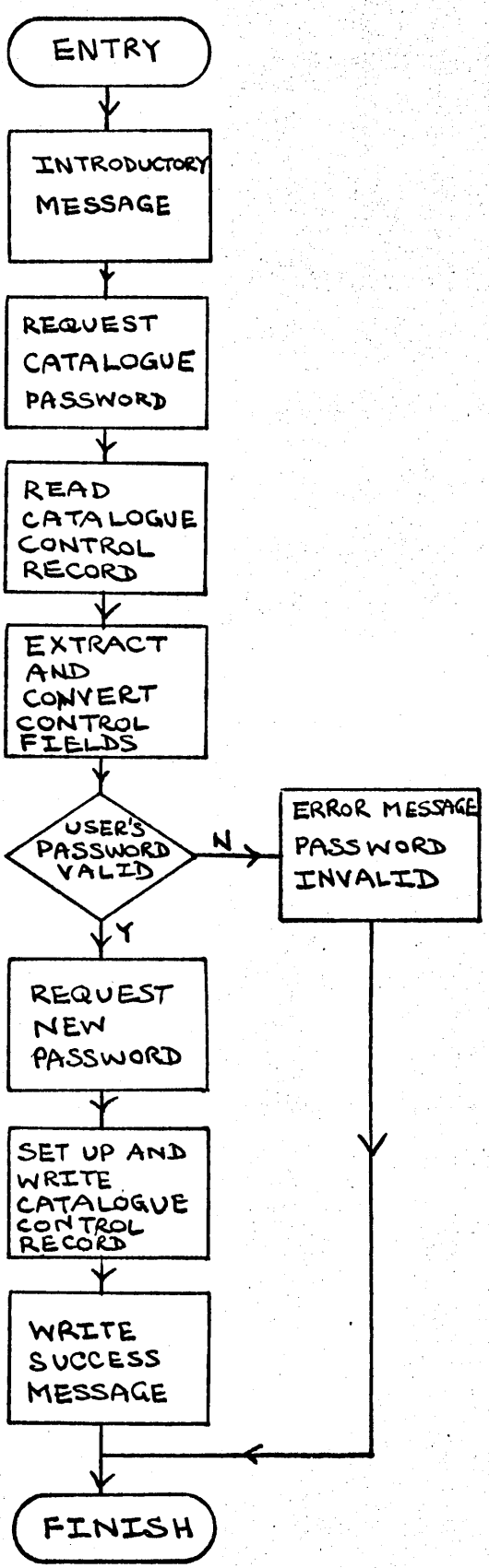
The user's response to the request for the number of security levels is validated. If it is the wrong length, non-numeric or numeric but outside the permitted range an error message is output on the user's terminal. The user is then prompted to enter a correct value.

The current date and time are obtained from the system executive and the control record is built up and written to the CATALOGUE subfile. The macro concludes by printing a message to say that the catalogue is now ready for use.

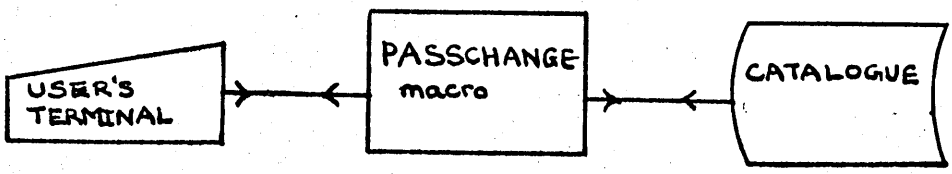
A listing of the CREATE macro is included in the separate

the separate folder (Item 11) and the dialogue from a typical run is shown together with the contents of the control record in Appendix IX (Section 19).

Figure 7.4 Outline processing for the PASSCHANGE macro



7.5 CHANGE THE CATALOGUE PASSWORD



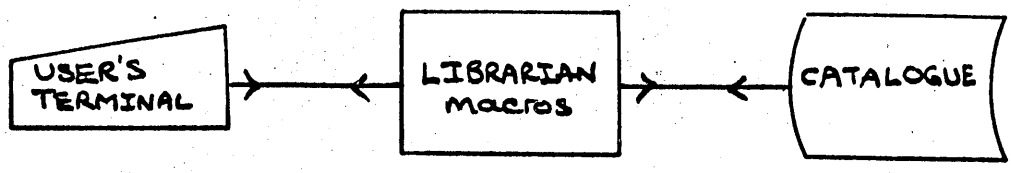
The PASSCHANGE macro enables the data base administrator to change the password in the catalogue control record.

The macro carries out a brief dialogue with the user to ascertain the old password. The catalogue control record is then read and the various fields extracted. If the old password has been correctly supplied the new password is requested. The current date and time are then obtained from the system executive and the catalogue control record is reconstructed to incorporate them and the new password. When the updated control record has been written on to the CATALOGUE subfile, the macro concludes by printing a message to say that the new password is effective (Figure 7.4).

An incorrectly entered old password causes the task to be abandoned after an error message has been output.

A listing of the PASSCHANGE macro is included in the separate folder (Item 12). Examples of the dialogue for an unsuccessful and a successful run are shown in Section 20 of Appendix IX.

7.6 INSERTING AND/OR DELETING CATALOGUE FILE DESCRIPTIONS



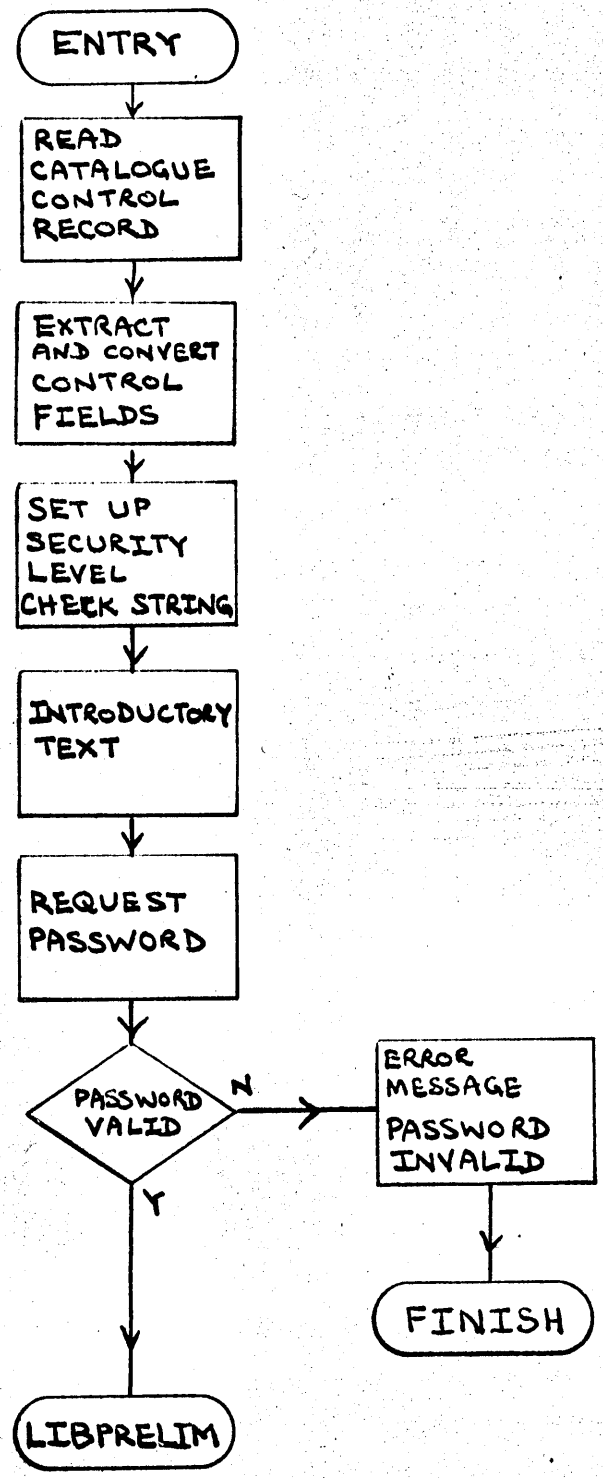
A set of chained macro definitions, the Librarian macros, is used to carry out the insertion and/or deletions of file descriptions in the catalogue. The macros are chained because of the large number of macro-time statements required to gather and validate all the information needed to add a file description to the catalogue. In order to modify a file description it is first necessary to delete the old description and then to insert the new description.

Because the security processing for the insertion and deletion of a file have common features in the checking of passwords and file names, it is convenient to carry out the catalogue amending processes by means of four macros - LIBRARIAN, LIBPRELIM, LIBDELETE and LIBADD. Figure 6.3 illustrates the function and linkage of these macros.

The dialogue for amending the catalogue is not tutorial and prompt instructions usually occupy only one or two lines. The text is therefore located within the macro definitions instead of in a text subfile.

The following subsections give ouline descriptions of each of the Librarian macros.

Figure 7.5 Outline processing for the LIBRARIAN macro



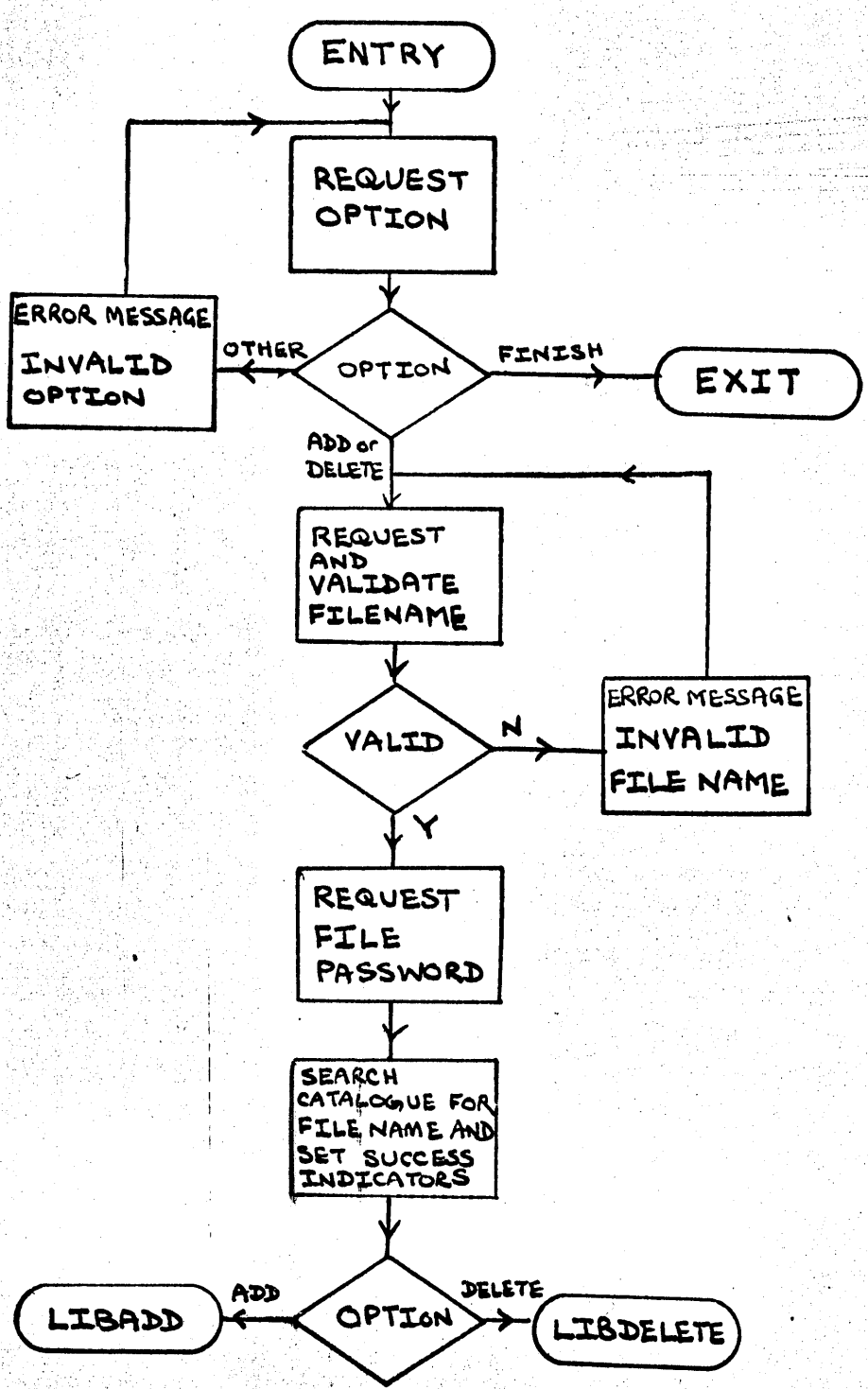
7.6.1 LIBRARIAN macro

The LIBRARIAN macro is the 'root' macro in the chain of macros for updating the CATALOGUE subfile. It prints out the introductory text and then requests the user's password to the catalogue. Only users able to enter a character string which is the same as the password in the catalogue control record are allowed to proceed further (Figure 7.5).

Global and string variables are used to pass details of file name, password, file and record counts, error codes, record pointers, etc between the chained macros. The LIBRARIAN macro extracts the file, record and security level counts from the catalogue control record and converts them to binary form for later use by the other macros. A check list of valid security levels separated by commas is also built up in string variable #S08 for use by the LIBADD macro.

A listing of the LIBRARIAN macro is included in the separate folder (item 13). Examples of both unsuccessful and successful executions of this macro are shown in Section 21 of Appendix IX.

Figure 7.6 Outline processing for the LIBPRELIM macro



7.6.2 LIBPRELIM macro

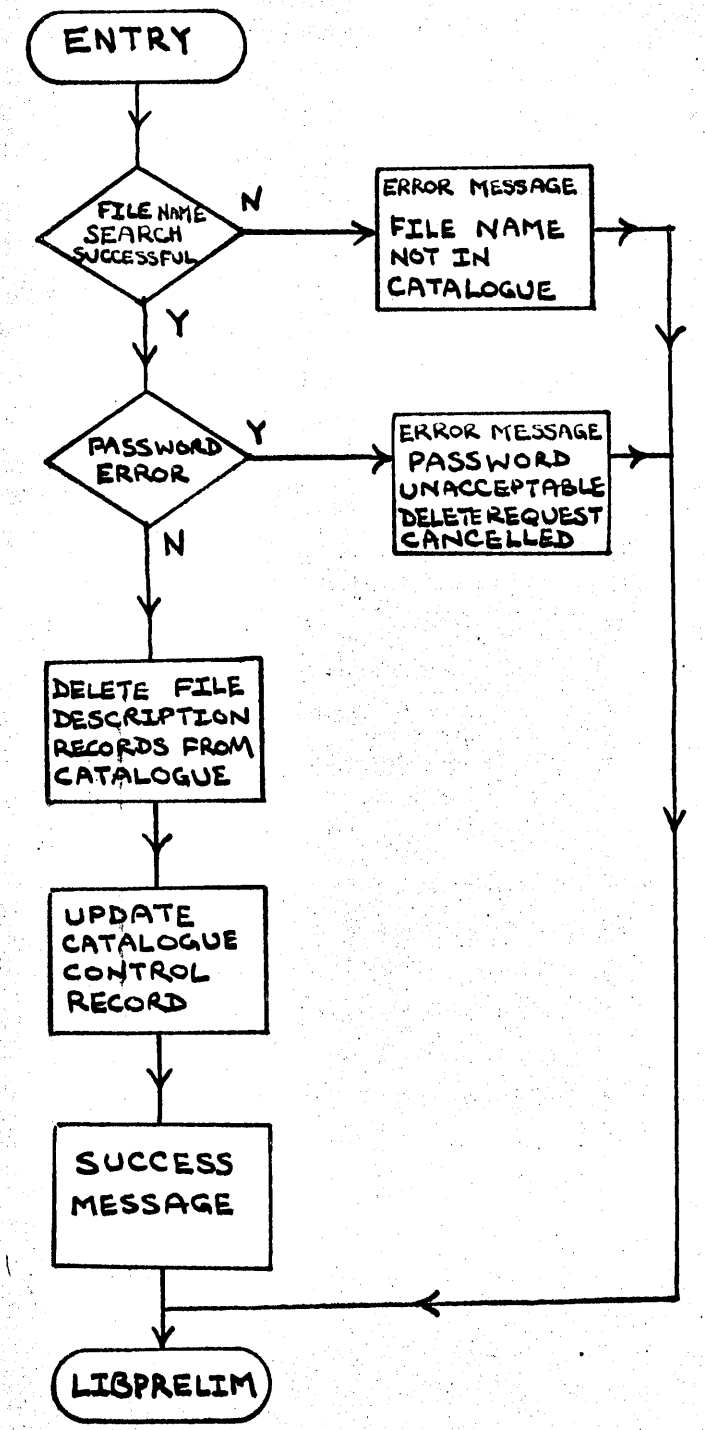
This macro definition establishes the option the user wishes to invoke and carries out the preliminary validation of file names and passwords prior to the execution of the LIBADD or LIBDELETE macro. The macro processing is illustrated in Figure 7.6 and falls into five main tasks:

1. Option dialogue
2. File name validation
3. Password dialogue
4. Catalogue search
5. Chain to the macro for the selected option

The Librarian macros enable the user to add and/or delete several file descriptions during a session at the computer terminal.

Further processing details are given in Appendix VII (Section 5). An example of the dialogue produced by the LIBPRELIM macro is included in Appendix IX (Section 22) together with samples of the LIBDELETE macro output. A listing of the LIBPRELIM macro is included in the separate folder (Item 14).

Figure 7.7 Outline processing for the LIBDELETE macro



7.6.3 LIBDELETE macro

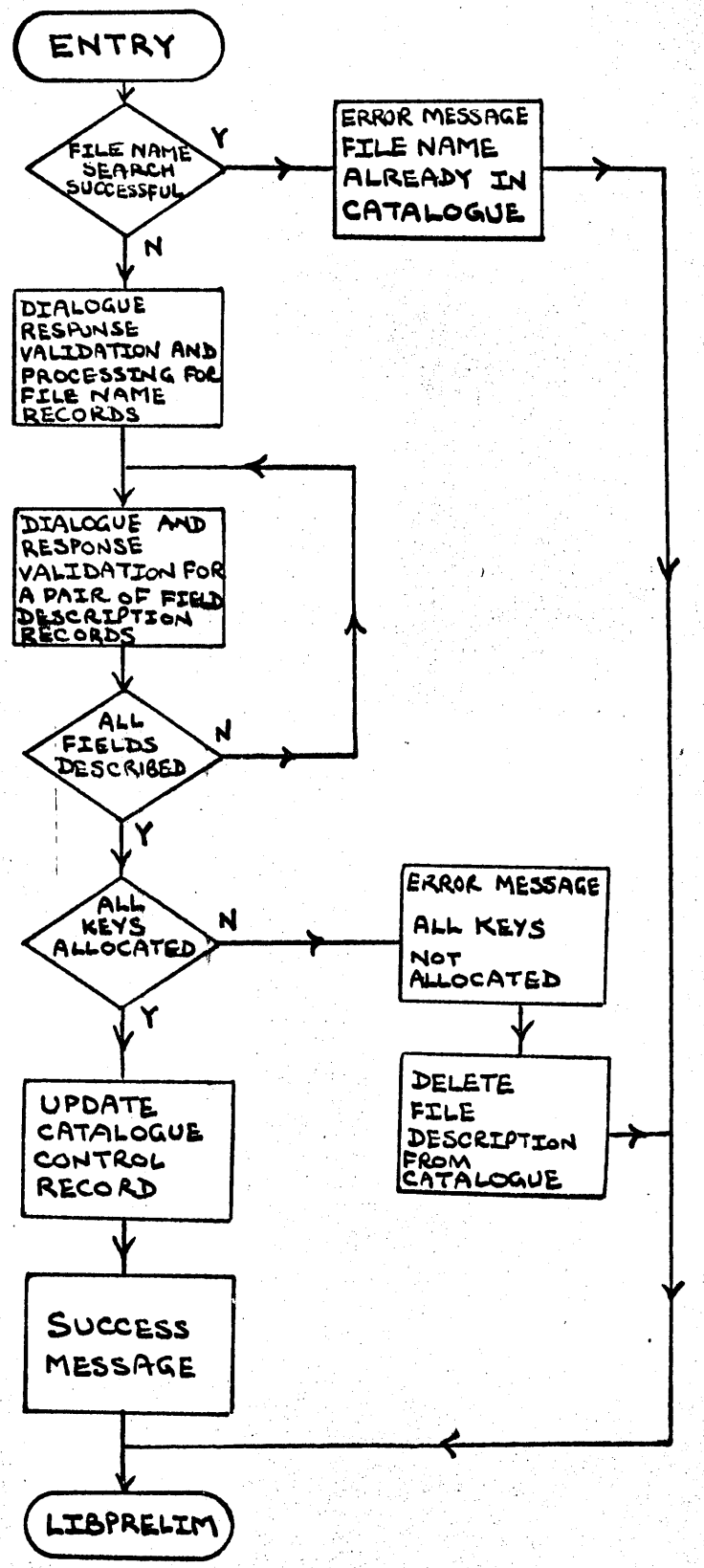
This macro deletes a file description from the CATALOGUE subfile after verifying both its existence and the user's authority to initiate the deletion. The macro processing is illustrated in Figure 7.7 and consists of six main tasks:

1. Establish the existence of the file description.
2. Check that the user has supplied the correct password.
3. Delete the file description records form the CATALOGUE subfile.
4. Update the CATALOGUE subfile control record.
5. Output the successful deletion message.
6. Chain to the LIBPRELIM macro.

Further processing details for these tasks are given in Section 6 of Appendix VII.

The dialogue in Section 22 of Appendix IX is a sample of that produced by the LIBPRELIM and LIBDELETE macros and illustrates both unsuccessful and successful attempts to delete a file description from the CATALOGUE subfile. A listing of the LIBDELETE macro appears as Item 15 in the separate folder.

Figure 7.8 Outline processing for the LIBADD macro



7.6.4 LIBADD macro

The LIBADD macro carries out a dialogue with the data base administrator to gather all the information required to set up and insert records for a new file description into the CATALOGUE subfile. It is by far the largest of the macros in the Librarian chain because of the volume of information which has to be requested and validated. The formats of the CATALOGUE subfile records are given in Appendix V (Section 1).

Figure 7.8 shows the processing ouline for the LIBADD macro which consists of the following main tasks:

1. Establish that the catalogue does not already contain the description of a file with the same name.
2. Gather the data for the file name records and insert them in the CATALOGUE subfile.
3. Gather the data for the pairs of field description records and insert them in the CATALOGUE subfile.
4. Check that all sequence keys have been allocated.
5. Update the CATALOGUE subfile control record.
6. Output the successful insertion message.
7. Chain to the LIBPRELIM macro.

Further processing details for these tasks are given in Appendix VII (Section 7).

A listing of the LIBADD macro is included in the separate folder (Item 16). A sample of the LIBADD dialogue is shown in Appendix IX (section 23), but it does not attempt to exhaustively illustrate the error messages which invalid user responses can provoke. Also shown in the same section is a listing of the CATALOGUE after the file description has been successfully added.

Much of the validation processing for the LIBADD macro described in Appendix VII could be used as the basis for a macro to

edit an existing file description. Such a macro would, however, be as large if not larger than the LIBADD macro.

7.7 USE OF ROUTINES

As is usual in programming practice, sections of code which are common to more than one macro definition or which are executed several times within a macro, or both, are formed into routines.

Among the larger routines which appear in more than one macro are those for:

1. Checking that a user devised name obeys the rules for a COBOL data-name.

2. The validation of user specified conditions and the generation of the appropriate COBOL condition statements.

Detailed descriptions of such routines are given in Appendix VII and usually follow the description of the macro in which they are first used.

Among the smaller more frequently used routines there are four which it is useful to mention at this point. The tasks they perform are as follows:

1. PROMPT routine - Issue a prompt, read the user's reply and detect a plea for help.

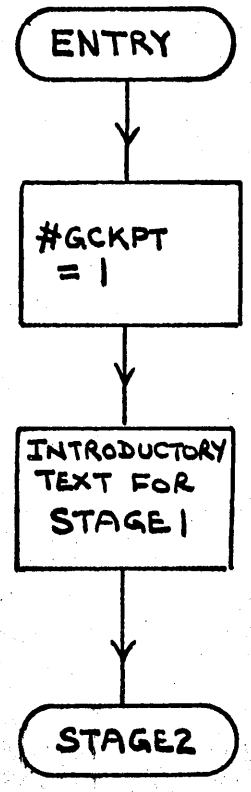
2. SEARCH routine - Binary search the domain dictionary for a particular domain or temporary item name.

3. INVALID RESPONSE routine - Output the 'Invalid response' message.

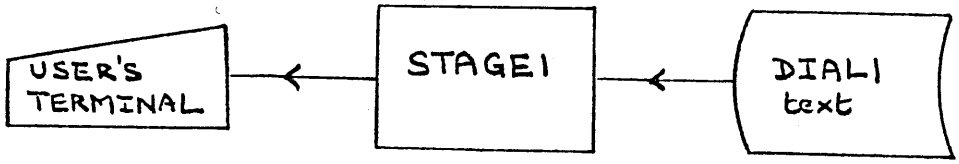
4. DEFAULT RESPONSE routine - Output the 'Default response' message.

Further details of these routines are given in Appendix VII (Sections 1 to 4).

Figure 7.9 Outline processing for the STAGE1 macro



7.8 STAGE 1 - INTRODUCTION



The STAGE1 macro definition (Figure 7.9) is the first in the chain of macros which carry out the problem specifying dialogue. This macro performs the three tasks indicated below:

1. Sets the global variable used to contain the checkpoint number (#GCKPT) equal to 1. This variable is used to restart the COBOL generating system when the user requests help.

2. Prints the introductory text for Stage 1 which is stored in the DIAL1 subfile.

3. Chains to STAGE2, the next macro in the chain.

The DIAL1 subfile introductory text serves the following main purposes:

1. Introduces the self-teaching COBOL report program generator.

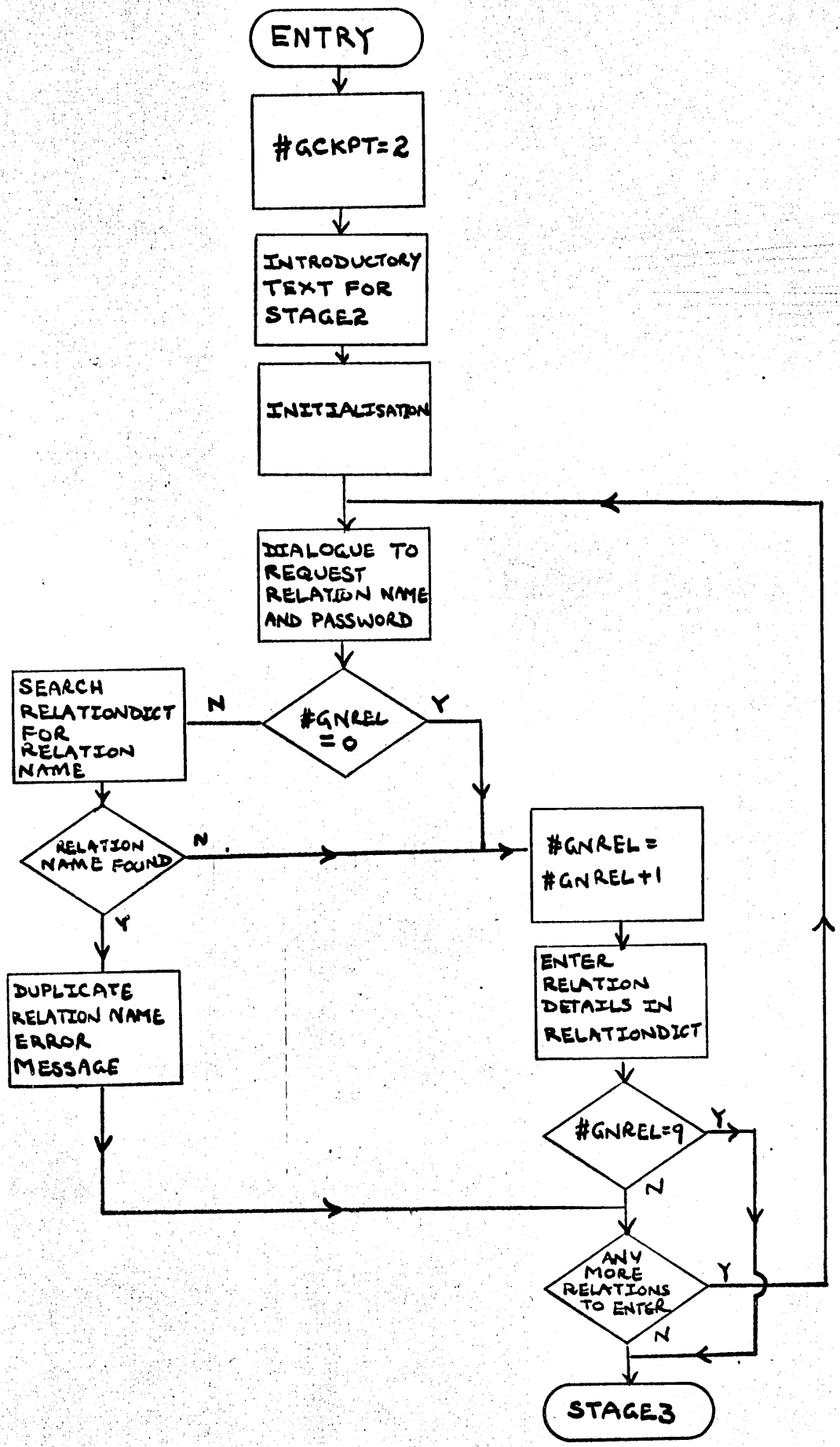
2. Informs the user how to obtain help by means of the %HELP response and how to abandon the terminal session altogether.

3. Describes to the user how he may take advantage of the default options offered in the ensuing dialogue.

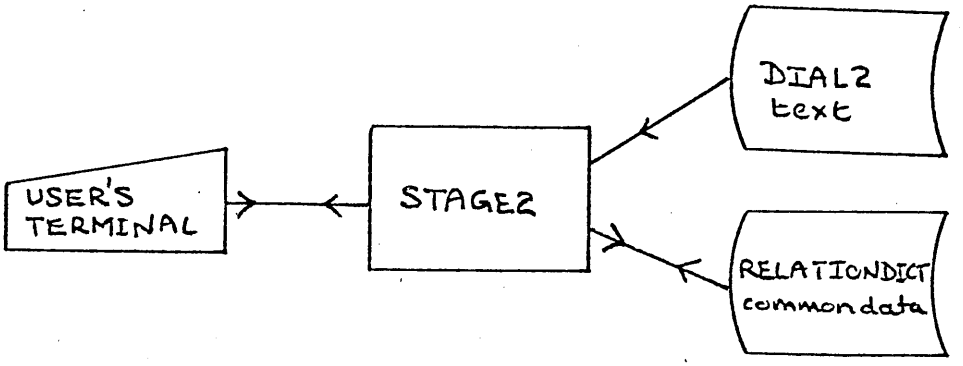
4. Introduces the concept of a relational data base and relates this to the tabular form commonly used to present data.

The computer dialogue output by the STAGE1 macro is illustrated in Appendix IX (Section 1) and a listing of the developed macro is included in the separate folder (Item 17).

Figure 7.10 Outline processing for the STAGE2 macro



7.9 STAGE 2 - PASSWORD DIALOGUE



The STAGE2 macro carries out a dialogue with the user in order to establish the name and password of each relation to which data access is required in order to solve the problem. The name and password details are recorded in the relation dictionary subfile, RELATIONDICT, for use by later stages of the COBOL generator.

Figure 7.10 shows the outline processing for the STAGE2 macro which consists of the following main tasks:

1. Set the checkpoint number variable (#GCKPT) equal to 2. This variable is used to restart the COBOL generating system after a request for help.

2. Print the dialogue describing the use of relation names and passwords for gaining access to data. The text for the dialogue is stored in the DIAL2 subfile.

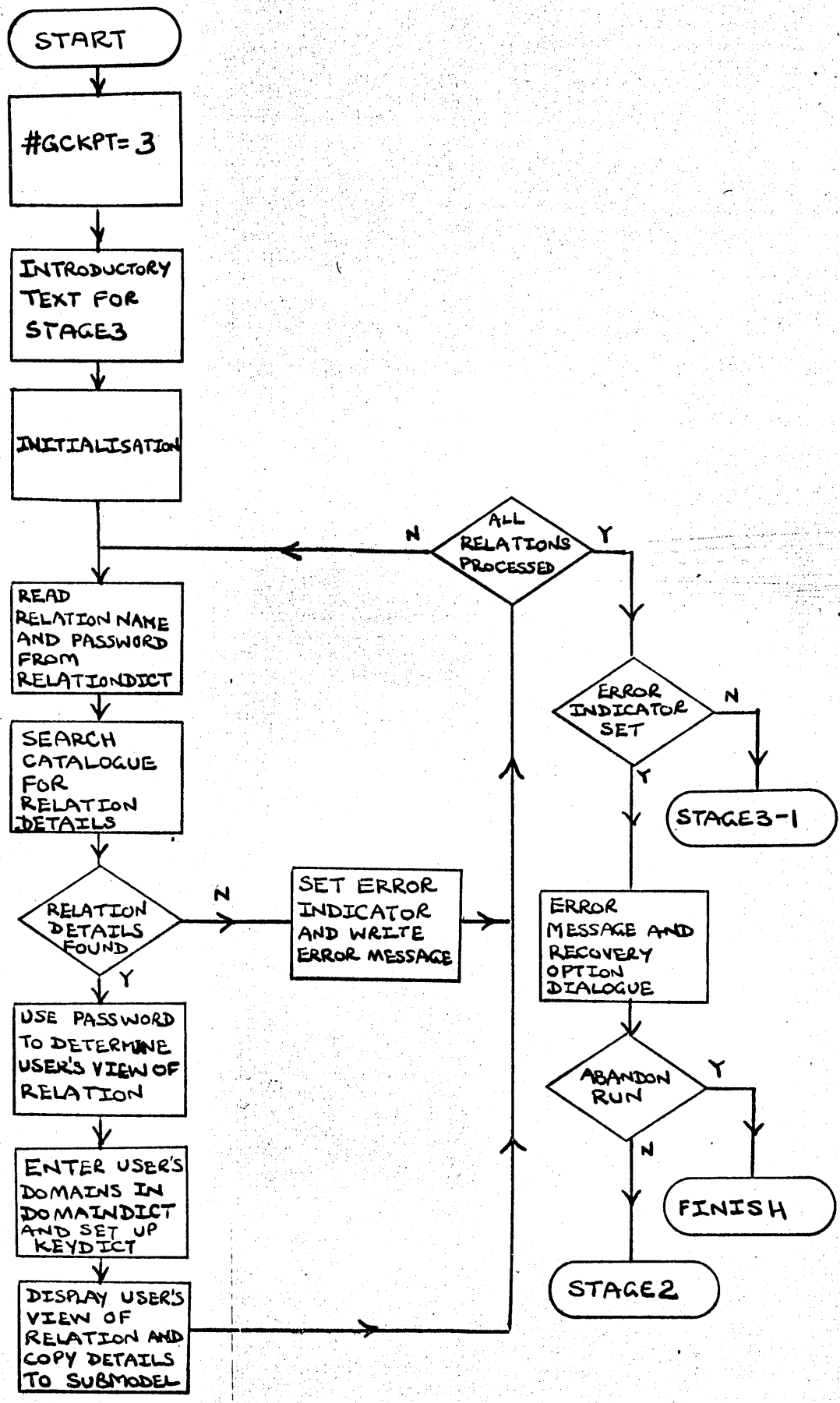
3. Prompt the user to enter up to nine relation names each with an associated password. Each unique relation name is counted and recorded together with its password in the RELATIONDICT subfile. Global variable #GNREL is used to contain the number of relations in the dictionary which is maintained in ascending relation name sequence. If the user duplicates a request for a particular relation, an error message advises him that the duplicate will be ignored.

4. When the user indicates that he has no further relation

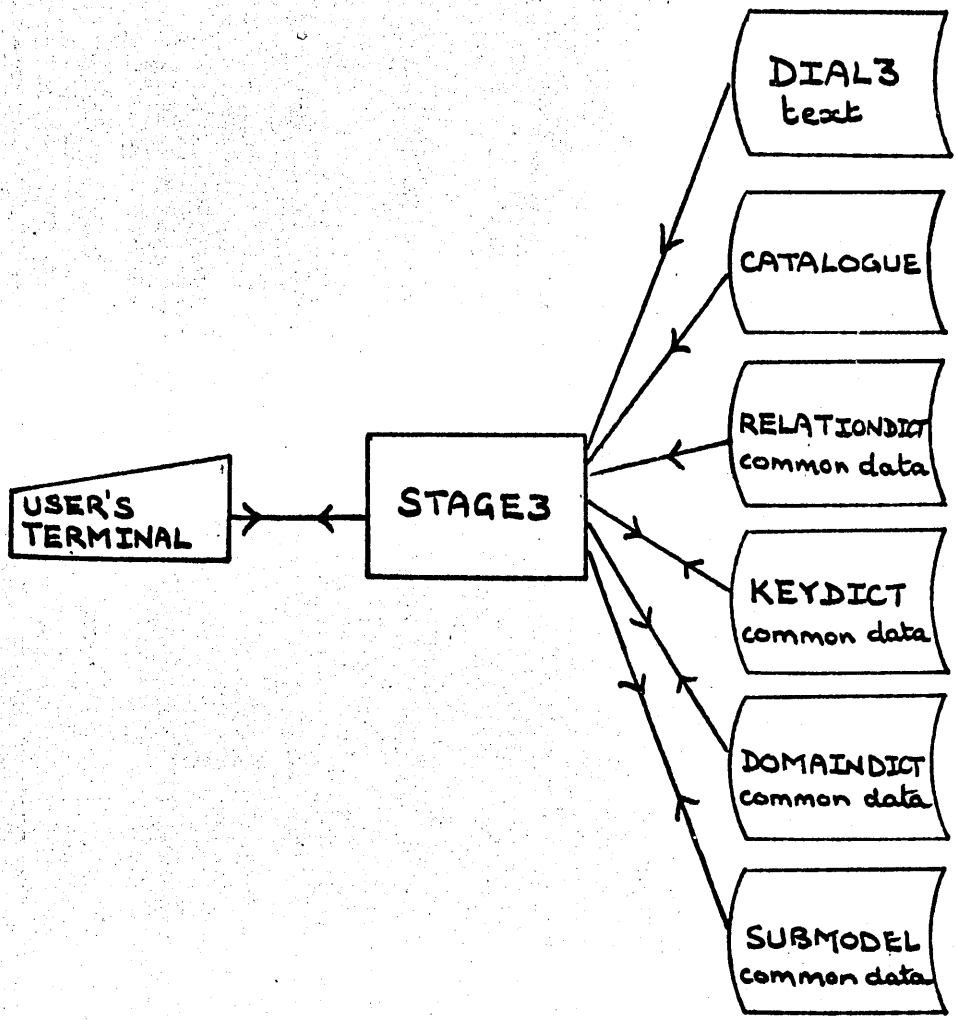
names to enter control passes to the STAGE3 macro which is the next link in the chain.

A sample of the dialogue produced by the STAGE2 macro is included in Appendix IX (Section 2) and a listing of the developed macro appears as Item 18 in the separate folder. Details of the format of the RELATIONDICT subfile are given in Appendix V (Section 2).

Figure 7.11 Outline processing for the STAGE3 macro



7.10 STAGE 3 - USER'S DATA BASE SUBMODEL

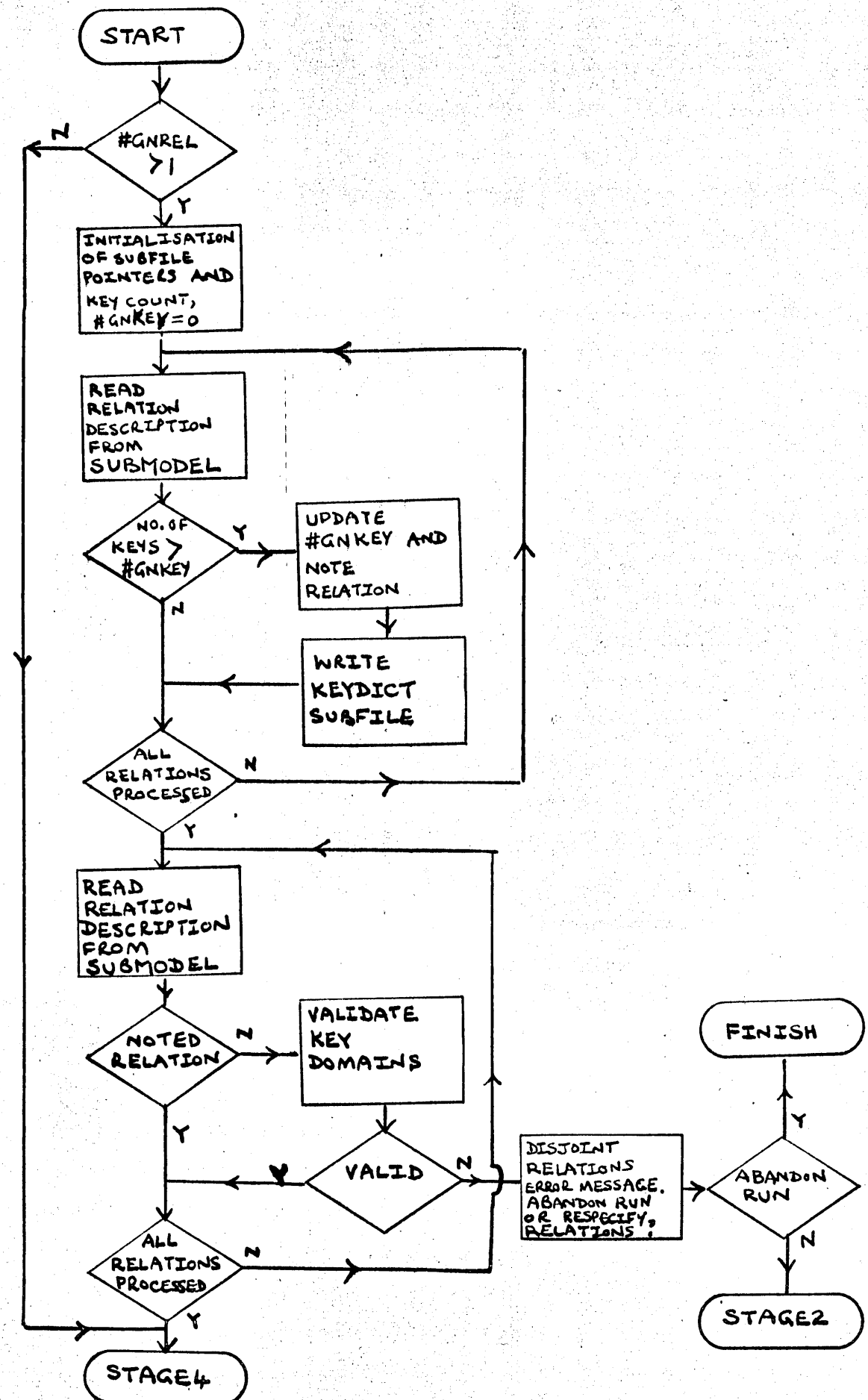


In the third stage of the problem specifying dialogue the user is shown details of the domains belonging to the relations whose names he entered in Stage 2 and to which he has password access.

The dialogue text for this stage is in the DIAL3 subfile. The contents of the RELATIONDICT subfile is used to determine which information in the CATALOGUE subfile should be displayed to the user.

During this stage data is recorded in three subfiles for later use by the generating system. These subfiles are called DOMAINDICT, KEYDICT and SUBMODEL and contain, respectively, details of all the domains to which the user may have access, the names of

Figure 7.12 Outline processing for the STAGE3-1 macro



the sequence key domains of the user's relations and the subset of catalogue file descriptions to which the user needs access. This processing is illustrated in Figure 7.11.

In addition to displaying details of the user's data base submodel, the Stage 3 processing verifies that the relations selected by the user are not disjoint or disconnected. This means that it will be possible to generate the COBOL file handling statements necessary to match up records from all the specified files. Figure 7.12 outlines this verification process.

The Stage 3 processing is carried out by two macro definitions, STAGE3 and STAGE3-1, the former automatically chaining to the latter on successful completion. It is possible that in subsequent versions of the COBOL generator that the criteria for defining disjoint relations may be relaxed (6.4.2), hence the decision to carry out this aspect of the Stage 3 processing in the separate STAGE3-1 macro.

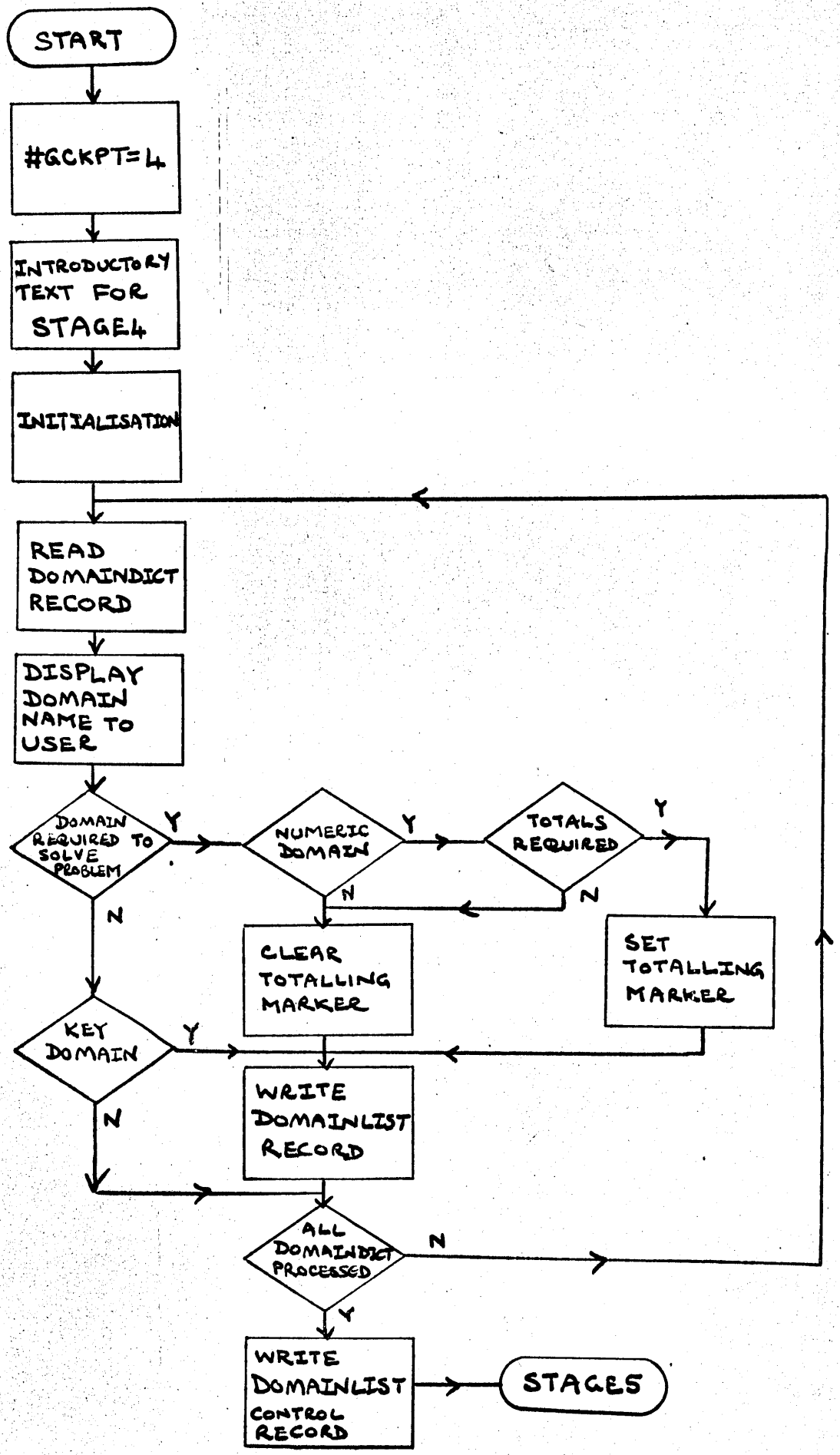
The data for the SUBMODEL and DOMAINDICT subfiles is recorded during the STAGE3 macro processing. In this macro the KEYDICT subfile is used only as temporary storage while the information about each relation is processed. When more than one relation is required for the problem, the permanent data for the KEYDICT subfile is recorded during the processing of the STAGE3-1 macro.

Format details for the three subfiles written during the third stage are given in Appendix V (Sections 3 to 5).

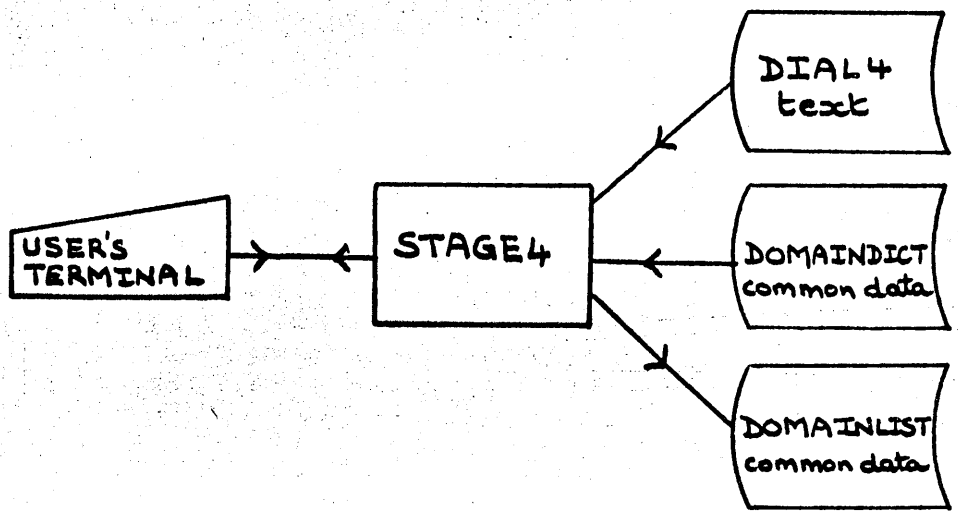
An example of the Stage 3 dialogue is given in Appendix IX (Section 3).

Further details of the processing in the STAGE3 and STAGE3-1 macros are given in Appendix VII (Sections 8 and 9) where future enhancements are also considered. Listings of these macros are included in the separate folder, although STAGE3-1 is not fully developed (Items 19 and 20).

Figure 7.13 Outline processing for the STAGE4 macro



7.11 STAGE 4 - SELECTION OF PROBLEM DOMAINS



During this stage the user is reminded of all the domains which are in the data base as viewed by him (Figure 7.13). As each domain name is displayed the user is invited to indicate whether or not it is required to solve the current problem. If the domain is required and it contains numeric data, the user is invited to avail himself of the automatic totalling facility. This facility will automatically accumulate the total of all the items in the domain which are retrieved from the data base.

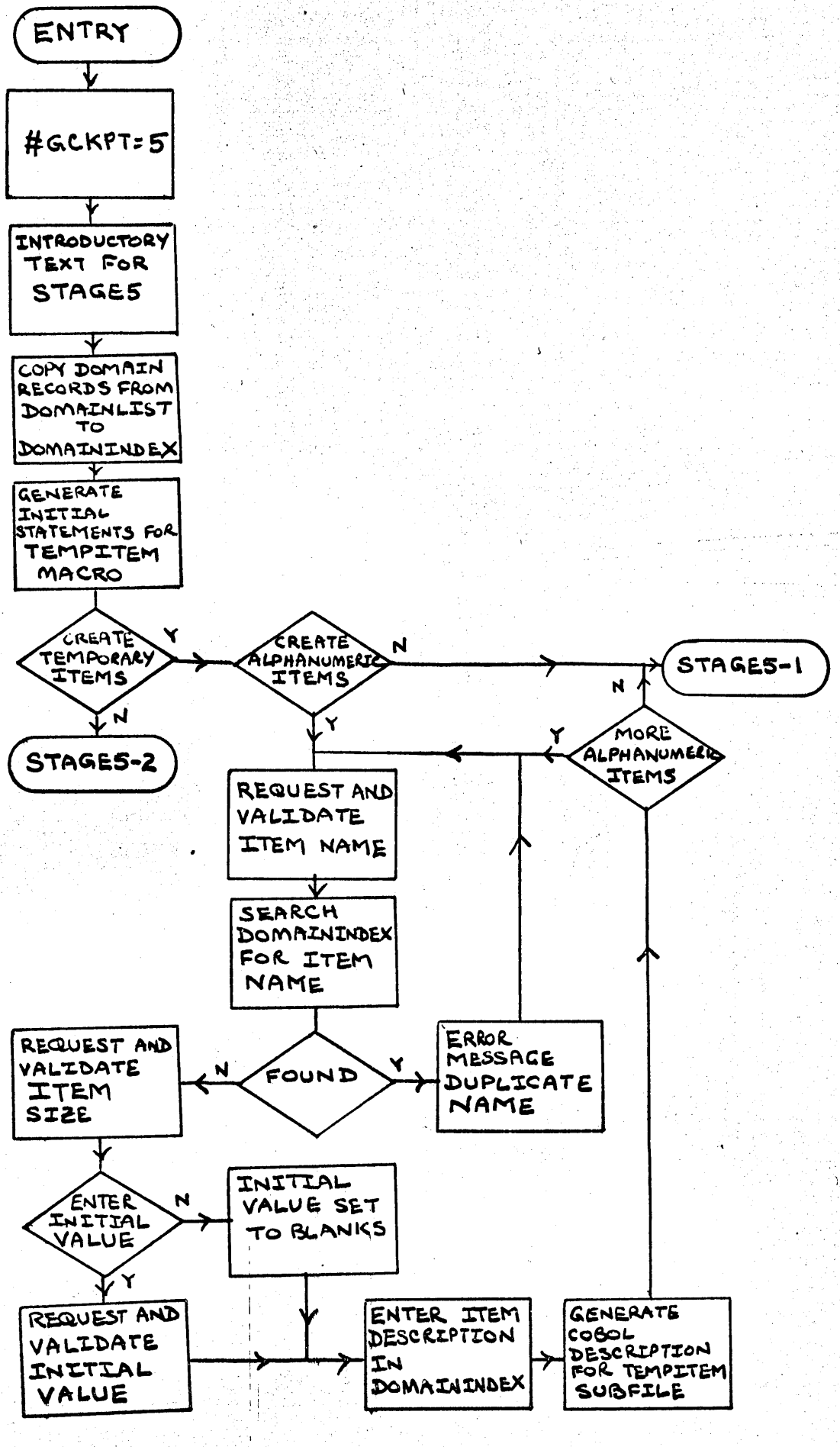
The STAGE4 macro uses the DIAL4 and DOMAINDICT subfiles as input and outputs data to the DOMAINLIST subfile. The DOMAINLIST subfile is similar to DOMAINDICT, but contains details of only those domains required to solve the problem. Each domain record, however, contains an extra field to indicate whether or not totals for it will have to be accumulated. Details of the record formats used in the DOMAINLIST subfile are given in Appendix V (Section 6).

An example of the Stage 4 dialogue is included in Appendix IX (Section 4). Processing details for the STAGE4 macro are given in Section 10 of Appendix VII and a listing of the partially developed macro is included in the separate folder (Item 21).

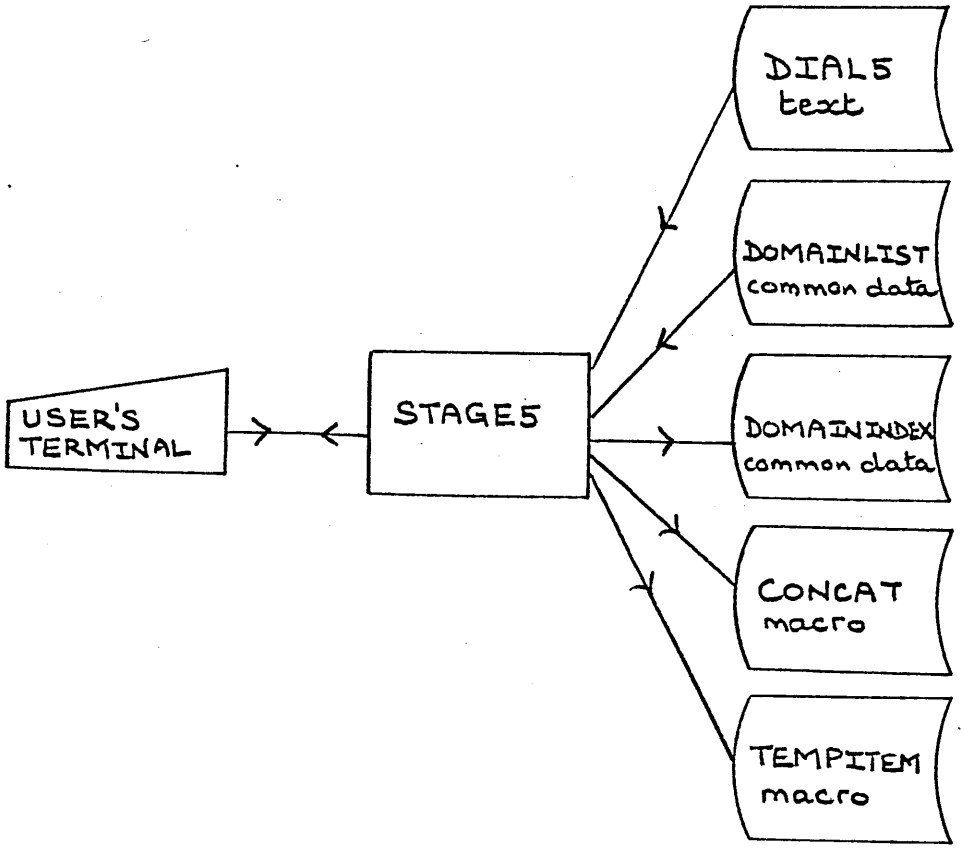
The design of the Stage 4 dialogue was greatly influenced by

the fact that the input/output device used for development was a teletype. If a more powerful device such as a visual display device unit was available, a dialogue adopting a 'menu' facility for the selection of problem data would be more appropriate.

Figure 7.14 Outline processing for the STAGE5 macro



7.12 STAGE 5 - TEMPORARY EXTENSION OF THE DATA BASE



This stage allows the user to extend his data base by the creation of temporary items or domains which are available only to the COBOL program currently being generated. The temporary data belongs to one of three categories:

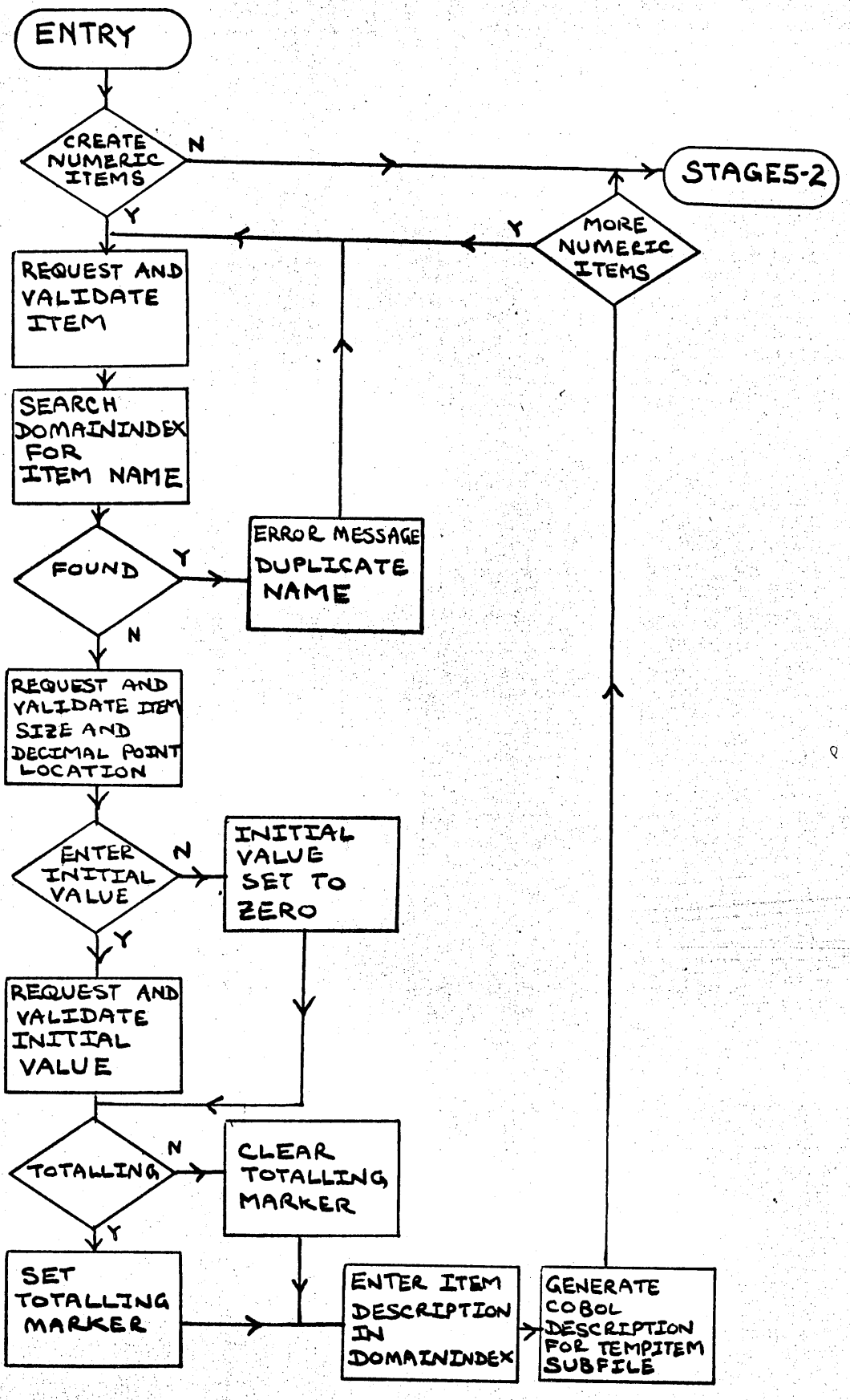
1. Alphanumeric
2. Numeric
3. Compound alphanumeric

For convenience the Stage 5 processing is carried out by three macro definitions, STAGE5, STAGE5-1 and STAGE5-2, one for each category.

Apart from the totalling facility for numeric items, the setting of initial values and the use of temporary data is entirely under user control. Initial values are specified in this stage and the processing is specified in Stage 18.

The Stage 5 processing uses subfiles DIAL5 and DOMAINLIST as input and outputs data to three subfiles, DOMAININDEX, TEMPITEM

Figure 7.15 Outline processing for the STAGE5-1 macro



and CONCAT. The DOMAININDEX subfile is similar to DOMAINLIST, but it is without the initial record and also contains information about the temporary and compound domains created by the user. The format details for the DOMAININDEX subfiles are given in Appendix V (Section 7).

The count of DOMAININDEX records is maintained in global variable #GDMCT so that it can readily be updated by any of the three macros. TEMPITEM and CONCAT are macro definition subfiles, the statements for which are generated during this stage.

The TEMPITEM macro is used during the synthesis of the generated COBOL program to insert data description statements for temporary data, if any. The macro takes the form:

```
%DEF   TEMPITEM
%      LABELOFF
                  COBOL data description statements for
                  temporary and compound items
%      LABELON
%END
```

The data description statements may be generated in any of the three Stage 5 macros from the user supplied information.

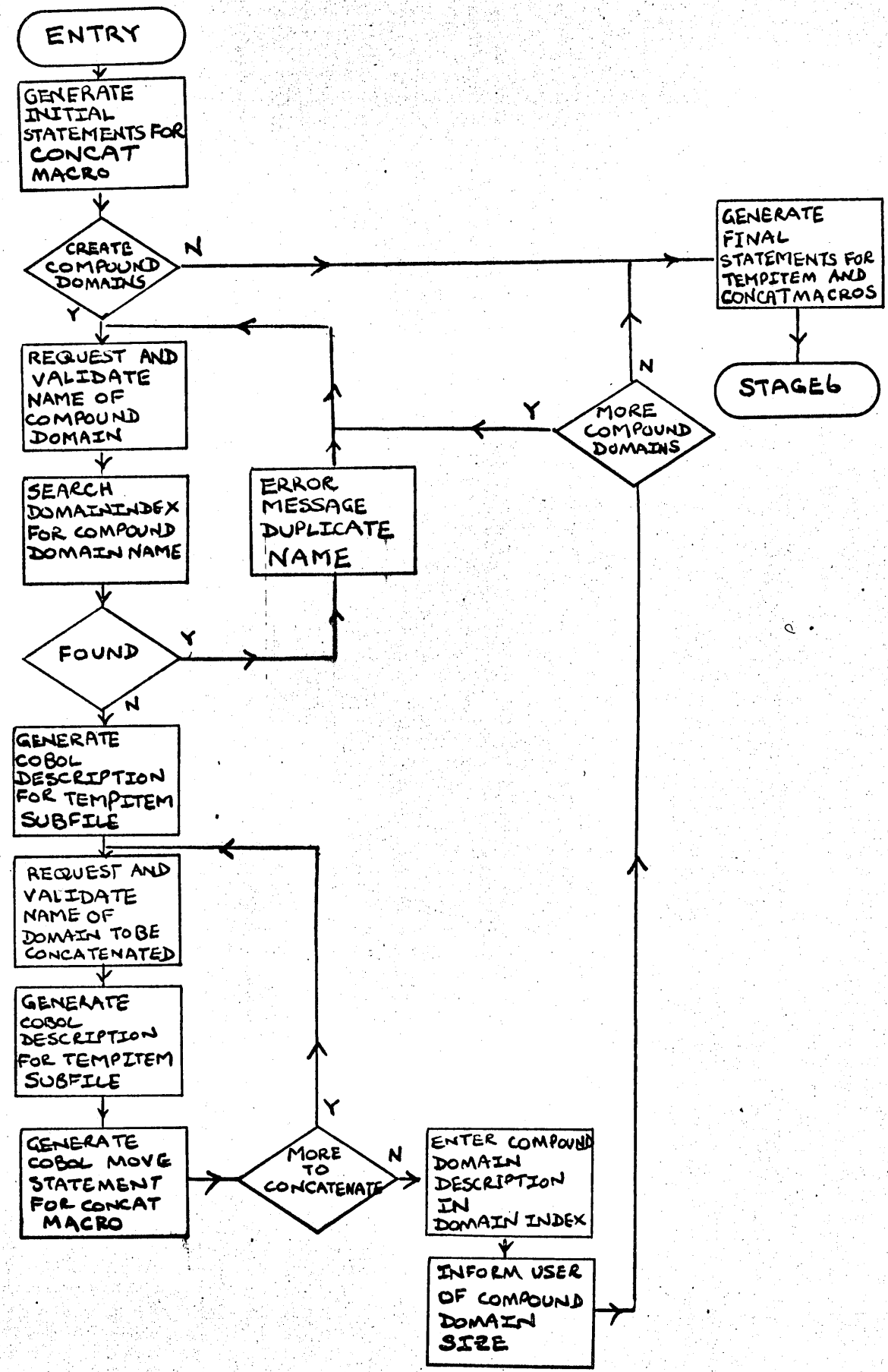
The CONCAT macro is used during program synthesis to insert MOVE statements which set up the data in the compound domains, if any. The macro takes the form:

```
%DEF   CONCAT
%      LABELOFF
                  COBOL MOVE statements to set
                  up data in compound domains
%      LABELON
%END
```

The MOVE statements are generated in the STAGE5-2 macro from the information about compound domains supplied by the user.

A useful enhancement to the Stage 5 macros would be a data summary. A list of all the temporary and compound domains created during the stage could be output on the user's terminal. There is also potential for extending the HELP macro facilities to allow the user to inspect, possibly selectively, details of all the

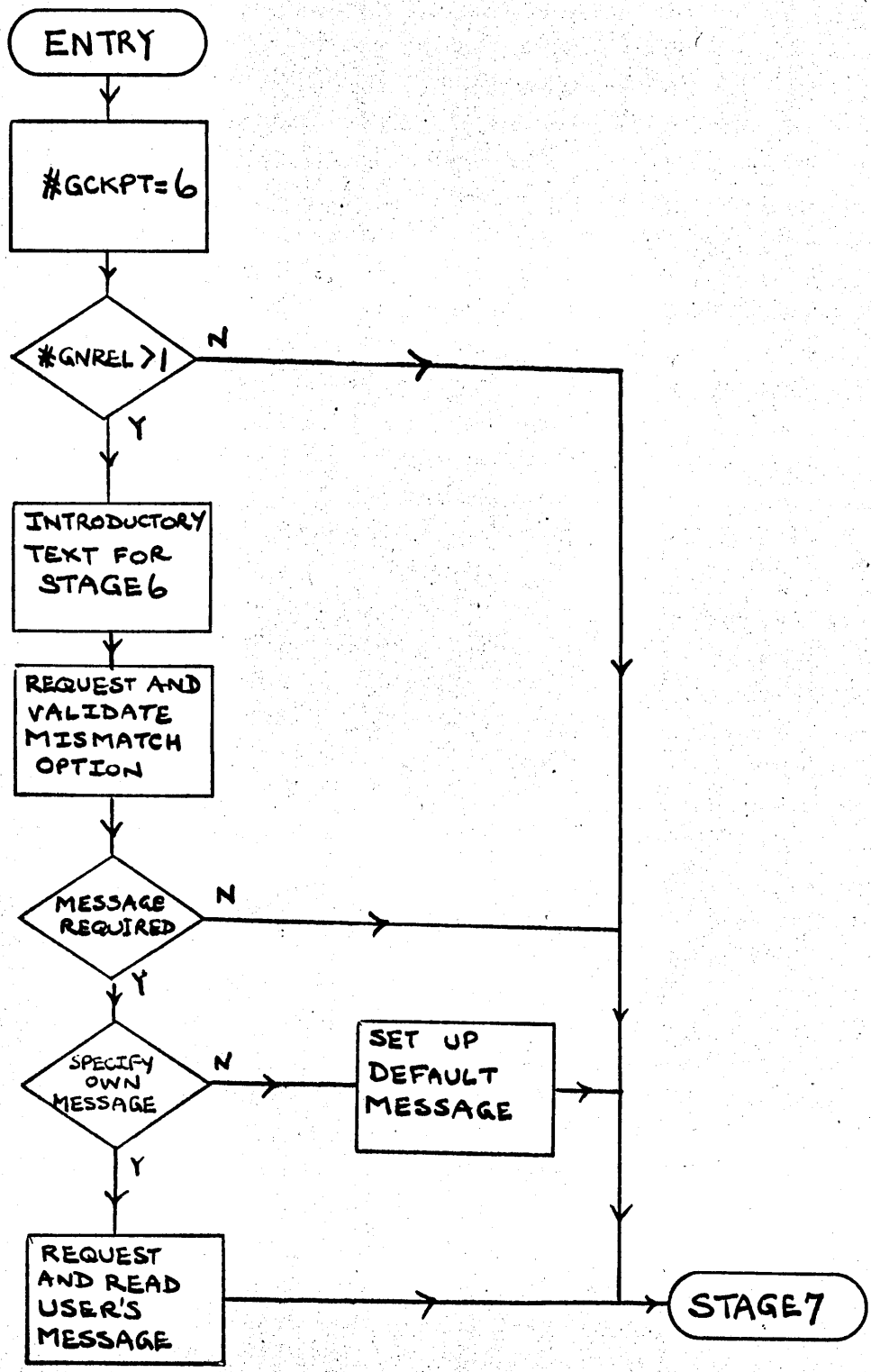
Figure 7.16 Outline processing for the STAGE5-2 macro



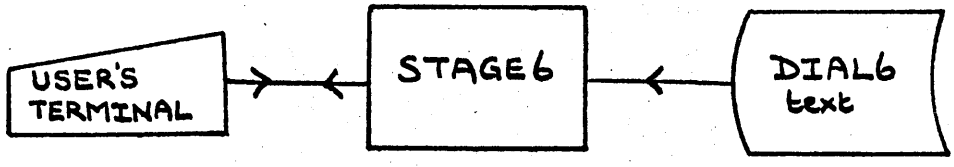
domains in his submodel data base.

The outline processing for the Stage 5 macros is illustrated in Figures 7.14 to 7.16 and further processing details are given in Appendix VII (Sections 11 to 13). An example of the Stage 5 dialogue is included in Appendix IX (section 5) and listings of the partially developed macros are included in the separate folder (Items 22 to 24).

Figure 7.17 Outline processing for the STAGE6 macro



7.13 STAGE 6 - DATA BASE INCONSISTENCIES



The user is only aware of the existence of the Stage 6 processing if more than one relation (file) is required to solve his problem.

Because the data files used by the generated COBOL program are created and maintained by other programs there may be a lack of integrity in the user's data base submodel. The user is offered a choice between three ways of handling any inconsistency encountered by the COBOL program when matching record keys from two or more data files:

1. The unmatched records may be ignored.

2. A dummy matching record may be created with zeros in the numeric non-key fields and blanks in the alphanumeric non-key fields.

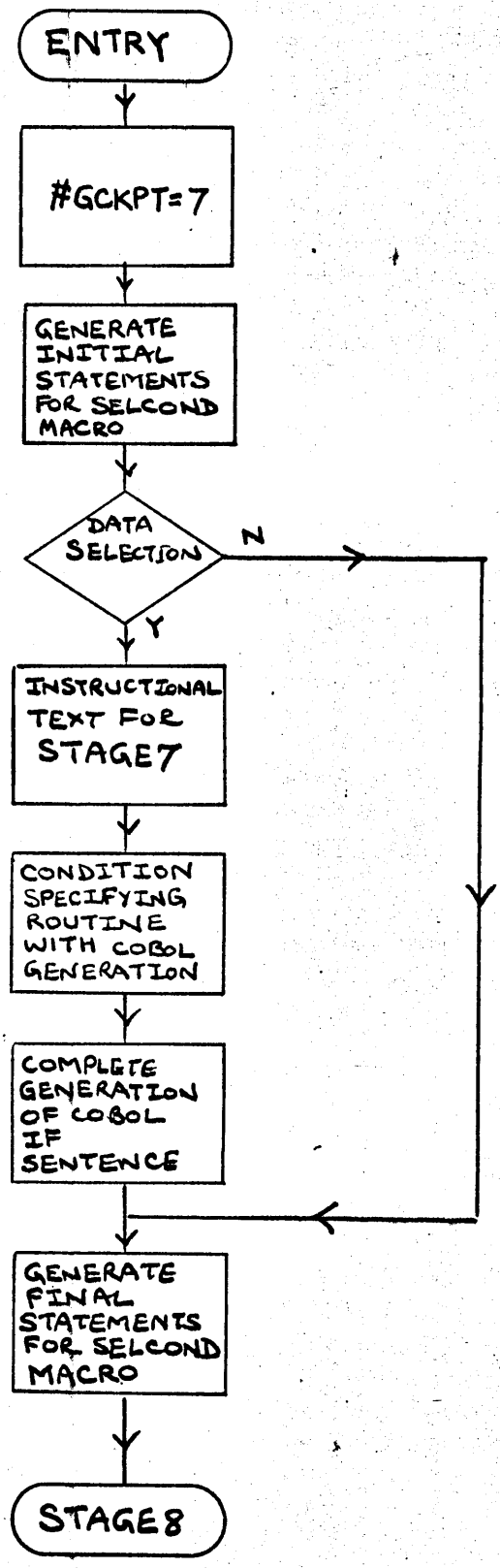
3. The run may be terminated.

In all cases the user is given the option of having an error message output by the program (Figure 7.17). The error message will give details of the relation name (file name) and the key value together with a brief comment, the text of which may be specified by the user.

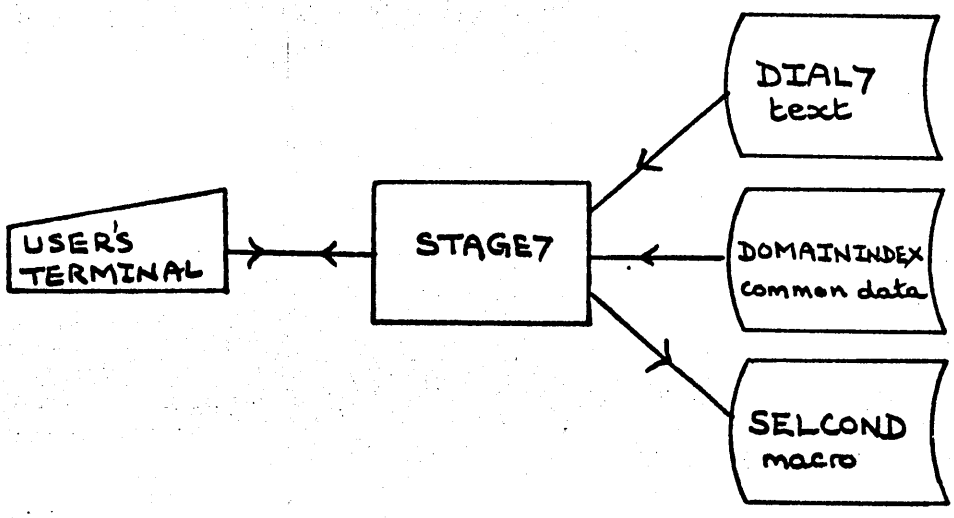
The STAGE6 macro uses the descriptive text stored in the DIAL6 subfile. The user's options are stored in global and string variables for use in a later stage.

A sample of the Stage 6 dialogue is included in Appendix IX (Section 6) and a listing of the partially developed macro is included in the separate folder (Item 25). Further processing details for the STAGE6 macro are given in Appendix VII (Section 14).

Figure 7.18 Outline processing for the STAGE7 macro



7.14 STAGE 7 - SELECTION OF DATA FOR RETRIEVAL



The STAGE 7 macro dialogue finds out whether all the data retrieved from the data base should be included in the report or if only a selection is required. In the latter case the dialogue explains, with examples, the form of a simple condition and how several may be linked to form a compound condition. The user is then prompted to specify the selection condition applicable to his problem. When a compound condition is used it is entered as two or more simple conditions and the user is prompted to specify the appropriate conjunctions.

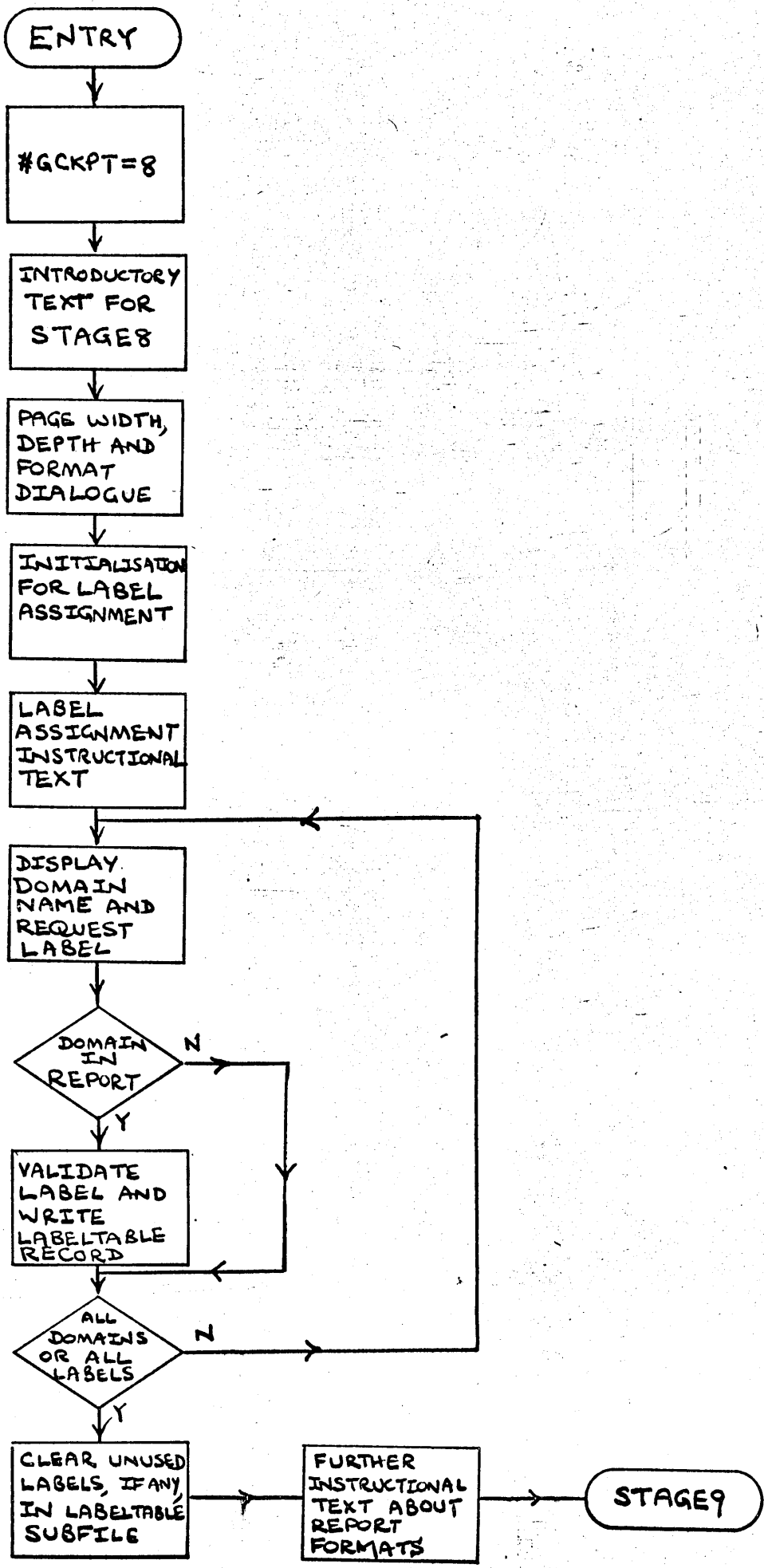
The instructional text for the STAGE7 macro is stored in the DIAL7 subfile and the macro also reads data from the DOMAININDEX subfile during the validation of the user's simple conditions. The SELCOND macro statements are generated at this stage. During the synthesis of the generated program the SELCOND macro is used to insert the COBOL conditional statements, if any, before those which process the retrieved data. The macro takes the form:

```
%DEF   SELCOND
%      LABELOFF
            IF
            --- COBOL condition -.-
            AND                          } Only if a    }
            --- COBOL condition ---       } compound     } Only if
            OR                           } condition    } conditional
            --- COBOL condition ---       } is used.     } selection
                \                                       } is made.
            GO TO Z-PARA-4. GO TO Z-PARA-5.
%      LABELON
%END
```

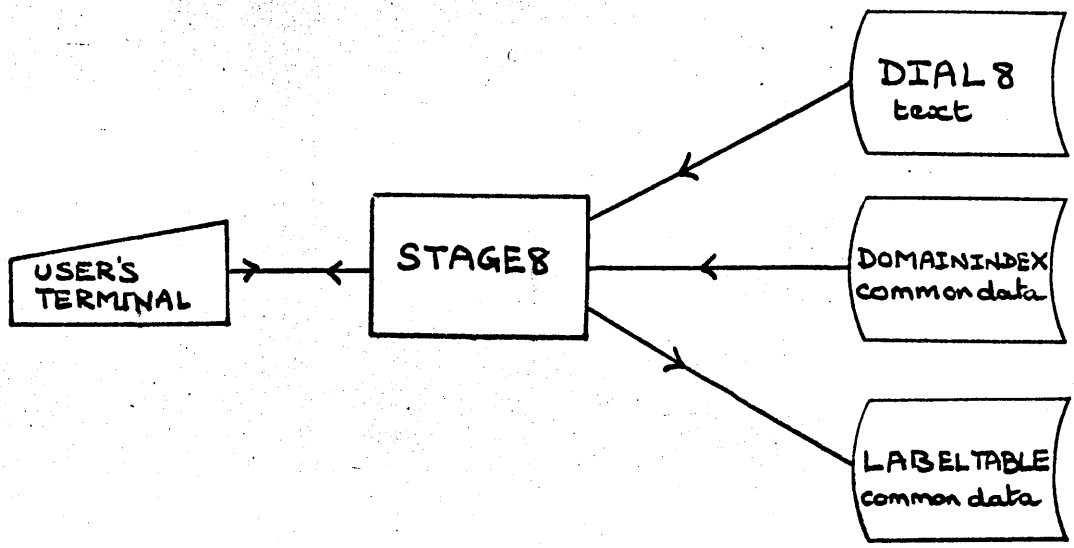
As the statements in the own code facility offered during Stage 18 may also be conditional, the condition specifying dialogue and validation of the user's responses are carried out by routines which are similar in both stages. The outline processing for the STAGE7 macro is illustrated in Figure 7.18. Further processing details for the STAGE7 macro and the condition specifying routines are given in Appendix VII (Section 15).

A sample of the Stage 7 dialogue is given in Appendix IX (Section 7) and a listing of the partially developed STAGE7 macro is included in the separate folder (Item 26).

Figure 7.19 Outline processing for the STAGE8 macro



7.15 STAGE 8 - REPORT LAYOUT INTRODUCTION



In this stage the user is invited to select the dimensions of his report page and is introduced to the notation used for specifying report line formats.

In order to specify report line formats a label character must be assigned to each domain or temporary item which appears in the report. The label character is used to denote the print positions to be occupied by the item. As there are nineteen possible label characters up to nineteen domain or temporary items may be included in the report (6.5.8).

The user is reminded of all the domains and temporary items which feature in his problem, and is invited to assign the label character of his choice to those which will appear in the printed report (Figure 7.19).

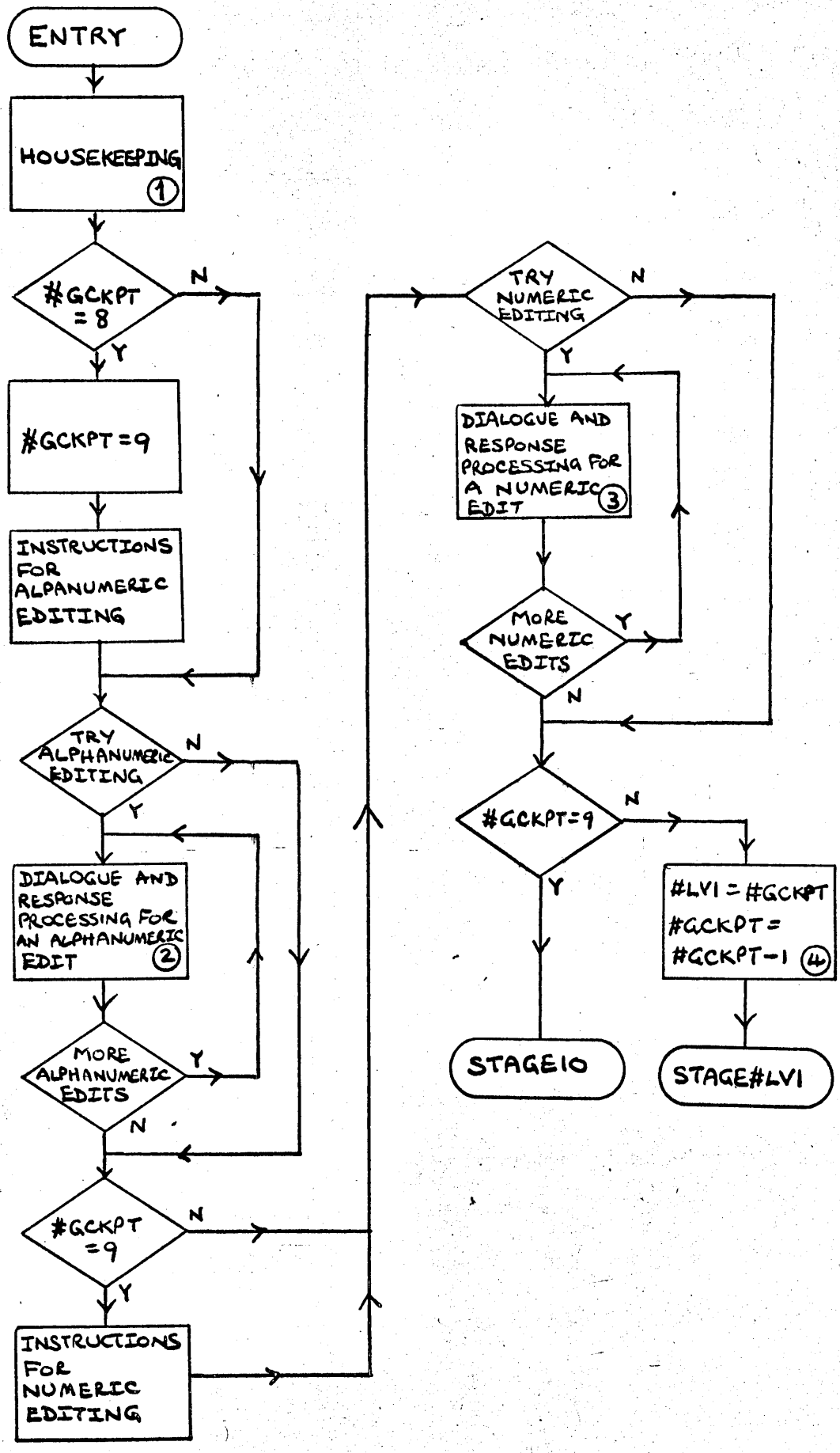
The instructional text for the STAGE8 macro dialogue is input from the DIAL8 subfile and details of the user's problem domains and temporary items are read from the DOMAININDEX subfile.

During the execution of the STAGE8 macro, details of the domain or temporary item associated with each label character used are recorded in the LABELTABLE subfile. In the records of unused labels all fields except the first are empty. The format of

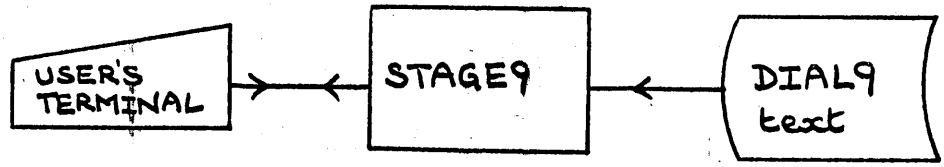
LABELTABLE subfile records is shown in Appendix V (Section 8).

A sample of the Stage 8 dialogue is included in Appendix IX (Section 8) and a listing of the partially developed macro is included in the separate folder (Item 27). Processing details for the STAGE8 macro appear in Appendix VII (section 16).

Figure 7.20 Outline processing for the STAGE9 macro



7.16 STAGE 9 - EDITING



In Stage 9, the user is introduced to the editing facilities available when alphanumeric or numeric items are printed in the report. The user is invited to experiment by designing editing formats, both alphanumeric and numeric, with an opportunity for seeing the result of editing data values of his choice. Figure 7.20 illustates the outline processing for the STAGE9 macro.

The STAGE9 macro is normally entered by chaining from the STAGE8 macro. It may, however, be entered from the HELP macro, where experimental editing is one of the facilities offered to users who have passed beyond the eighth stage of the problem specifying dialogue (Figure 7.2). On completion, the STAGE9 macro passes control either to the STAGE10 macro or to the macro from which the plea for help was made. The value of the checkpoint variable #GCKPT is used to determine the next macro in the chain.

The instructional text for the STAGE9 macro is stored in subfile DIAL9. This text is suppressed when the macro is entered via the help facility as the user will already have seen it.

The processing details for the STAGE9 macro are summarised in note form in Appendix VII (Section 17). The Stage 9 instructional text is illustrated in Appendix IX (Section 9).

7.17 GENERAL STRATEGY FOR PROCESSING REPORT OUTPUT FORMAT SPECIFICATIONS

The dialogue in which the formats of the different report output categories are specified is similar. However, it is more convenient to process each category of output in a separate stage for the following reasons:

1. In each category different field types are permitted.

2. There are variations in the COBOL Procedure division statements generated for each category.

3. The dialogue for any output category may be repeated after viewing a sample page in Stage 17, but they are not repeated in the original order.

4. The combined processing for all categories of output would result in a complicated macro too large for the PG/2 macro processor's internal stacks and tables.

In each stage in which the user opts to specify output formats statements for two macro definition subfiles are generated. One subfile has the name suffix REC and the other the name suffix PARA. Information is also written to a common data subfile which has the name prefix PAGE.

The body of the macro with the name suffix REC contains COBOL group descriptions for the non-blank records of the output category. The general form of the statements generated for the macro is as follows:

```
%DEF  ....REC
%     LABELOFF
       01  line-name-1.
           02  ...          }  Field descriptions  }  1st non-blank
           02  ...          }  for 1st line.       }  record
           ..  ....                                 }  description.
       01  line-name-2.                            }  2nd non-blank
           02  ...          }  Field descriptions  }  record
           02  ...          }  for 2nd line.       }  description.
      ...  ...,
%     LABELON
%END
```

These record descriptions are destined for the Working-storage section of the COBOL program.

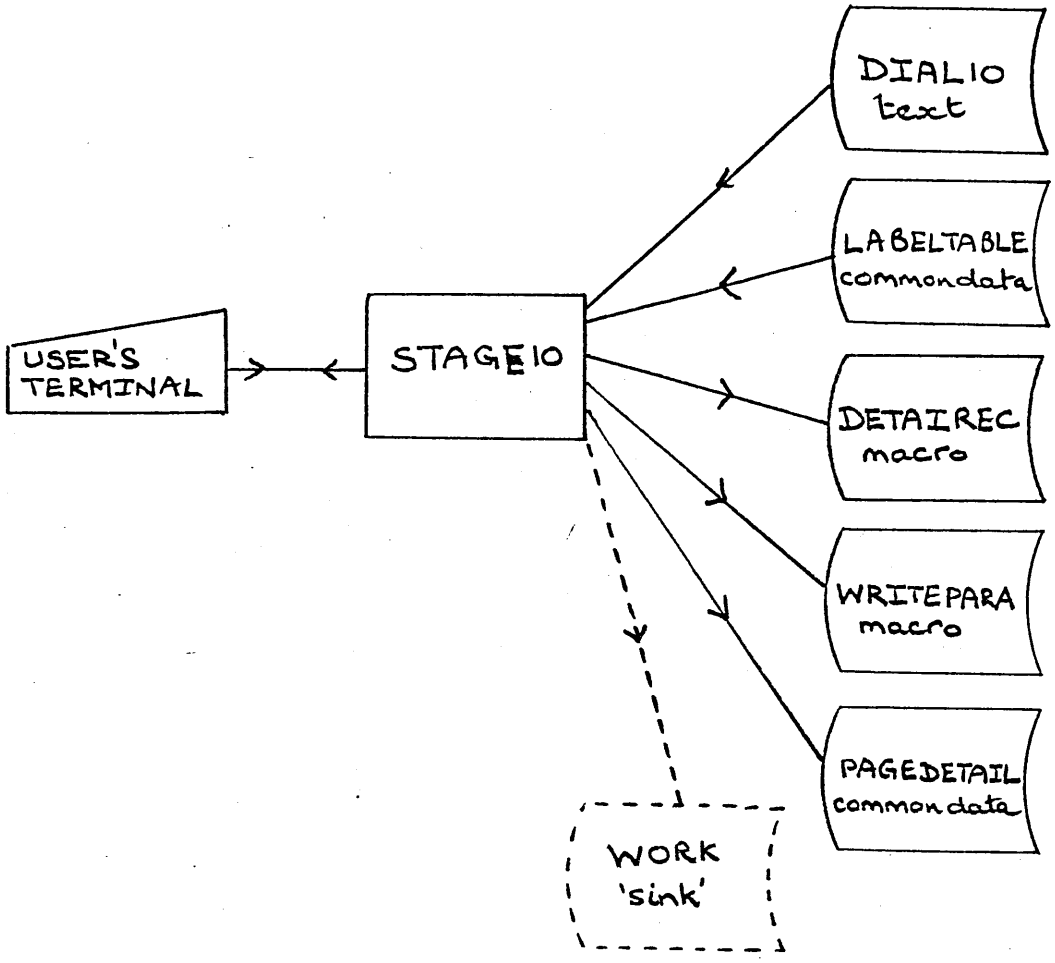
The body of the macro with the name suffix PARA contains the Procedure division statements which write out the non-blank lines of the output category.

For each valid line format specified by the user, a record is written to the subfile with the name prefix PAGE. In Stage 17 the contents of this subfile is used if the user wishes to view a sample page. All common data subfiles with the name prefix PAGE have the same format as that shown in Section 9 of Appendix V.

For each valid non-blank line format entered by the user statements are generated for both the REC and PARA name suffix macro definition subfiles. The statements generated for the former are saved in the subfile before the statements for the latter are generated.

The level 02 data description statements are generated as each field in the line format specification is identified and validated, but they are not filed until all the fields in the line have been processed. If an error is detected during the validation, the statements for the previous fields in the line, if any, are emptied on to the WORK subfile. This serves as a convenient 'sink' in which to empty the PG/2 ouput stack so that it is 'cleaned up' ready to process the user's corrected line format specification. A meaningful error message is output on the user's terminal and he is prompted to type in the amended line format specification.

7.18 STAGE 10 - DETAIL LINE(S) SPECIFICATION

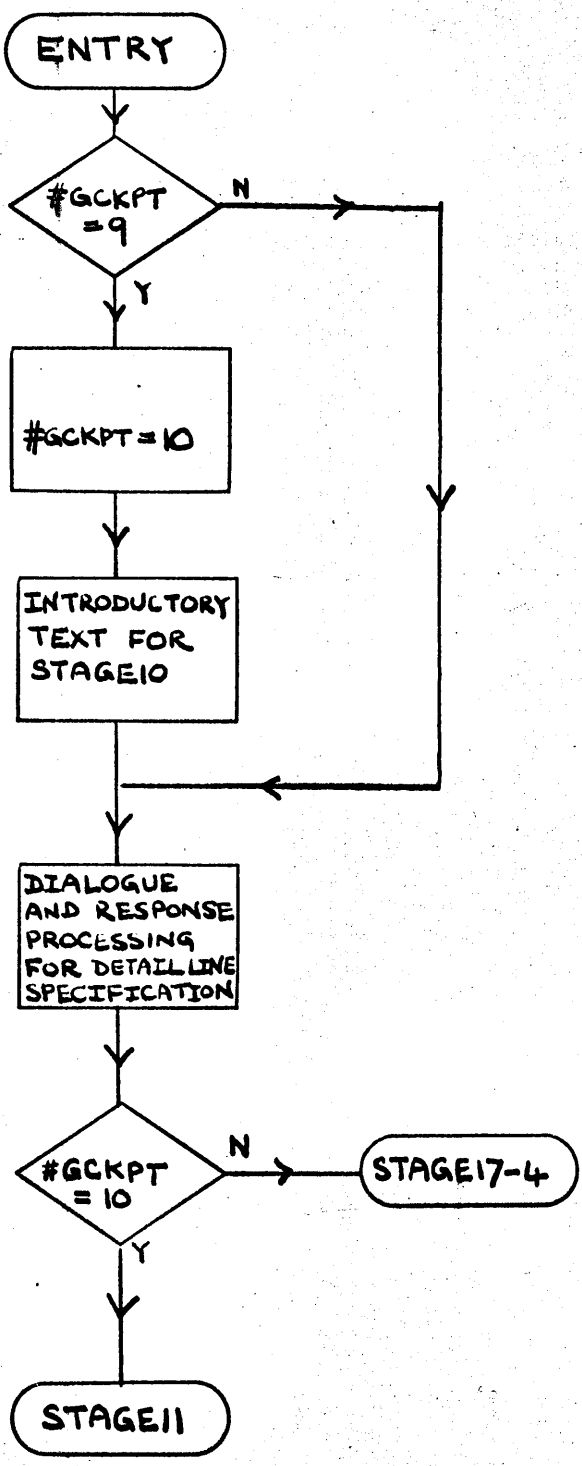


The STAGE10 macro carries out the dialogue in which the user specifies the formats of the detail lines which are to be printed for each retrieval from his data base. The outline processing for the STAGE10 macro is shown in Figure 7.21.

The macro uses two input subfiles, DIAL10 and LABELTABLE, and generates statements for macro definition subfiles DETAILREC and WRITEPARA. It also writes information on the common data subfile PAGEDETAIL. The WORK subfile is used only when a format specification error is detected.

A sample of the Stage 10 dialogue is shown in section 10 of Appendix IX.

Figure 7.21 Outline processing for the STAGE10 macro



7.18.1 STAGE10 macro processing notes

1. The STAGE10 macro is normally entered by chaining from the STAGE9 macro, but may also be entered from the STAGE17-3 macro.

2. Checkpoint variable #GCKPT is used to determine the method of entry and, on completion, the next macro in the chain.

3. Subfile DIAL10 contains the text which introduces the stage and describes the use of text literals. The DIAL10 text is output only if STAGE10 is entered normally.

4. The LABELTABLE subfile (Appendix V Section 8) is used during the validation of line format specifications.

5. The level 01 line-names used in the body of the DETAILREC macro are Z-DETAIL-1, Z-DETAIL-2 etc.

6. Particulars of the identification, validation and generation of the level 02 field descriptions for the four field types permitted in a detail line are given at the references indicated below:

Blank FILLER (Appendix VII Section 18.1)

Alphanumeric literal FILLER (Appendix VII Section 18.2)

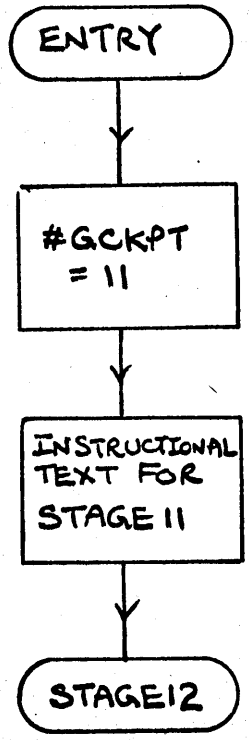
Alphanumeric data item (Appendix VII Section 18.3)

Numeric data item (Appendix VII Section 18.4)

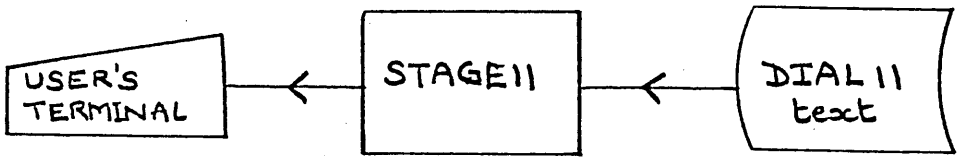
7. The COBOL statements generated for the body of the WRITEPARA macro will ultimately be located in the Z-PARA-WRITE paragraph. This paragraph is performed once for each tuple of data retrieved (See Appendix VII Section 19 for macro details).

8. Format details for the PAGEDETAIL subfile are given in Appendix V (Section 9).

Figure 7.22 Outline processing for the STAGE11 macro



7.19 STAGE 11 - EXTRA DATA ITEMS - DATE, TIME, PAGE NUMBER



In this stage the user is told of the extra data items, date, time and page number, which he may include in certain lines of his printed report. The text explaining which strings of characters should be used to denote the print positions of these extra data items is stored in subfile DIAL11.

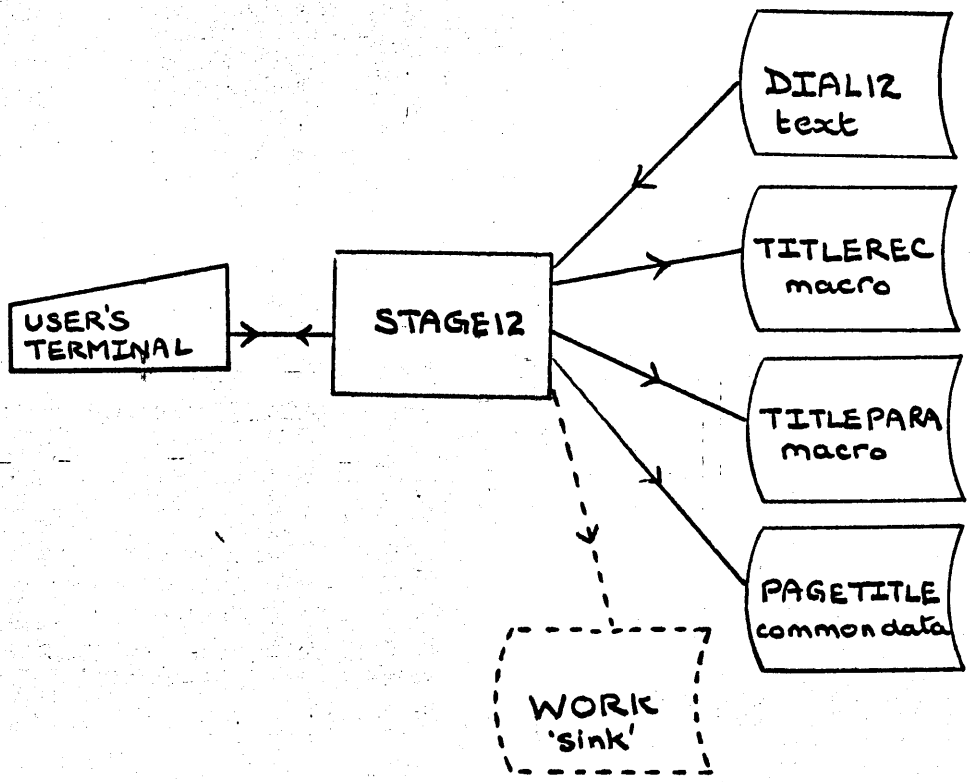
The processing in the STAGE11 macro, illustrated in Figure 7.22, consists of only three steps:

1. Set the checkpoint variable equal to 11.
2. Print the instructional text contained in the DIAL11 subfile.
3. Chain to the STAGE12 macro.

There are three main reasons for making the output of this instructional text into a separate stage, rather than incorporating it at the beginning of the next stage. First it reduces the volume of text displayed when the user restarts the report title specification after a plea for help. Secondly, there is potential for increasing the number of extra items accessible to the user, e.g. the line counter. Thirdly, users may find it desirable to be offered the use of these items earlier in the dialogue so that they may be included in detail line specifications. As a separate stage the order of the problem specification dialogue is more easily changed.

The instructional text for Stage 11 is illustrated in Section 11 of Appendix IX.

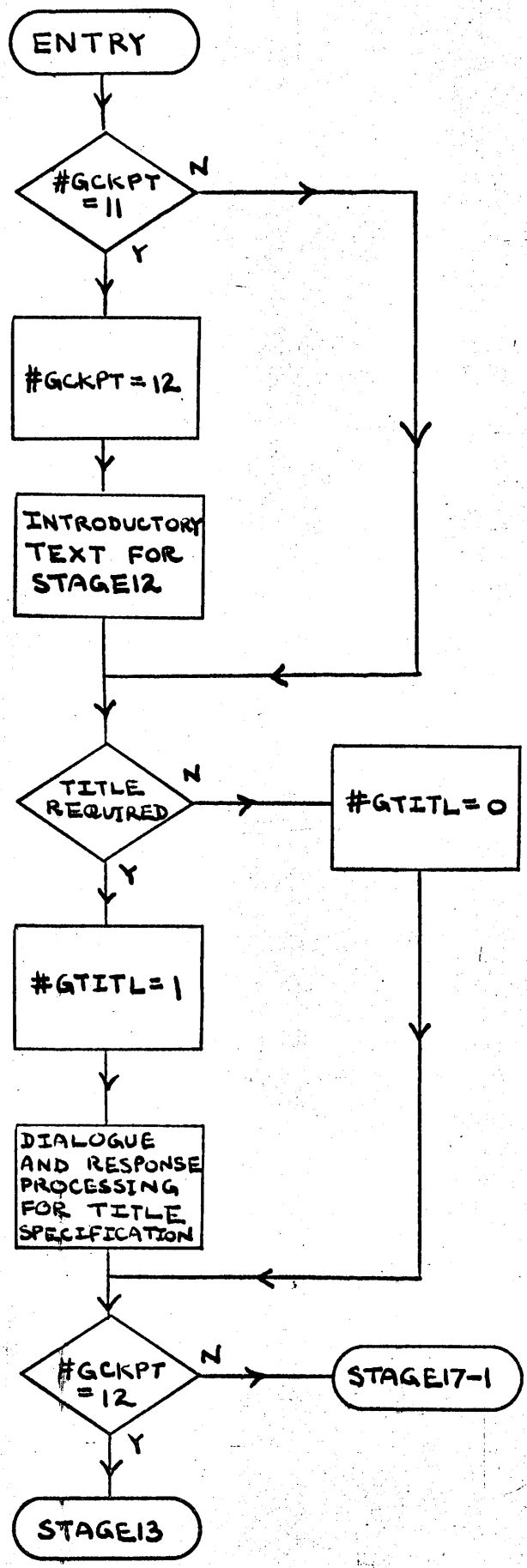
7.20 STAGE 12 - REPORT TITLE SPECIFICATION



The STAGE12 macro carries out the dialogue in which the user specifies the format of the report title, if required. The output subfiles shown in the above diagram are used only if a report title is specified.

A sample of the Stage 12 dialogue is shown in Section 12 of Appendix IX and the outline processing is illustrated in Figure 7.23.

Figure 7.23 Outline processing for the STAGE12 macro



7.20.1 STAGE12 macro processing notes

1. The STAGE12 macro is normally entered by chaining from the STAGE11 macro, but may also be entered from the STAGE17 macro.

2. Checkpoint variable #GCKPT is used to determine the method of entry and, on completion, the next macro in the chain.

3. The introductory text for the stage is output from the DIAL12 subfile, but only if the macro is entered normally.

4. Global variable #GTITL is used to indicate whether or not a report title is specified.

5. The line-names generated for the level 01 statements in the body of the TITLEREC macro are Z-TITLE-1, Z-TITLE-2 etc.

6. Particulars of the identification, validation and generation of the level 02 field descriptions for the five field types permitted in a title line are given at the references indicated below:

Blank FILLER (Appendix VII Section 18.1)

Alphanumeric literal FILLER (Appendix VII Section 18.2)

Date item (Appendix VII Section 18.5)

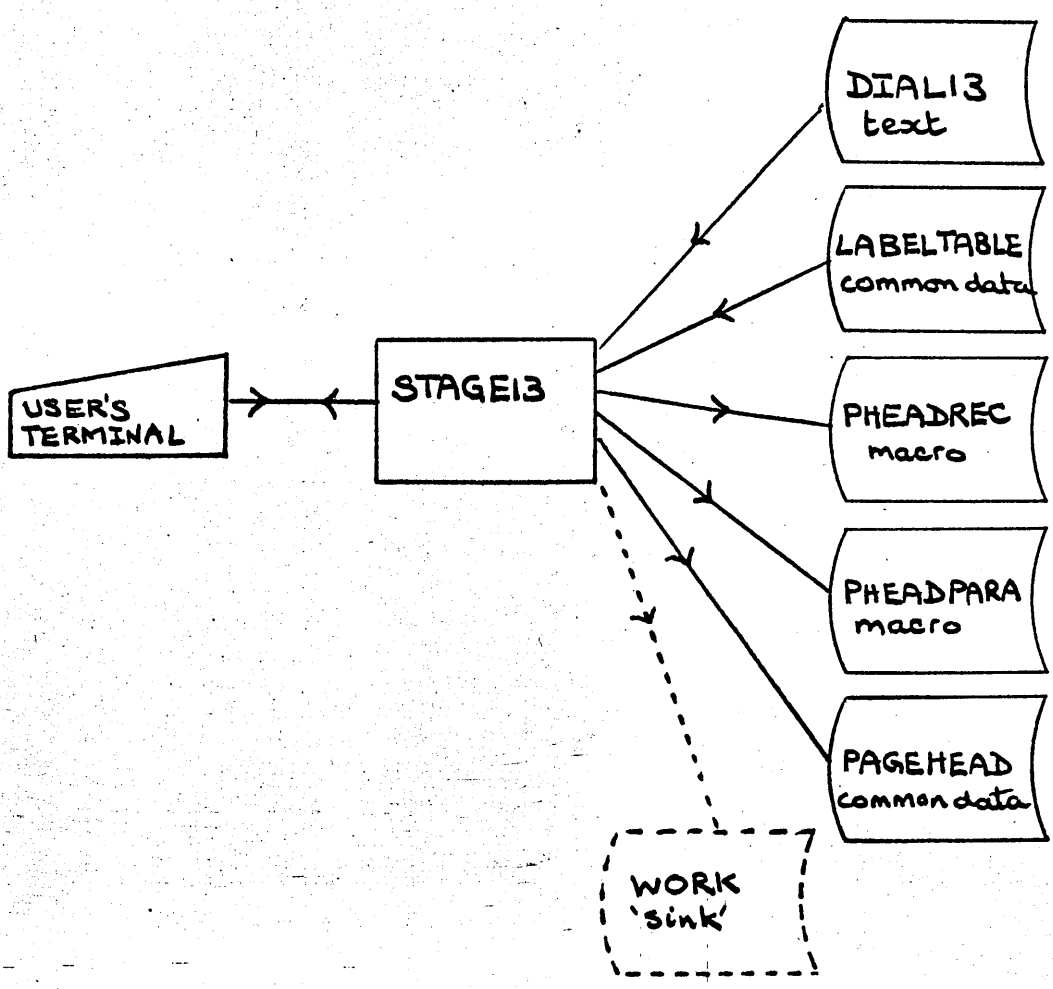
Time item (Appendix VII Section 18.6)

Page number item (Appendix VII Section 18.7)

7. The body of the TITLEPARA macro consists of COBOL Procedure division statements for the Z-PARA-TITLE paragraph which writes out the report title page. This paragraph is performed during the initial section of the COBOL program. The general form of the statements generated for the TITLEPARA macro is shown in Appendix VII (Section 20).

8. Format details for the PAGETITLE common data subfile are given in Appendix V (Section 9). Blank lines after the last non-blank title line are not included in the subfile.

7.21 STAGE 13 - PAGE HEADING SPECIFICATION

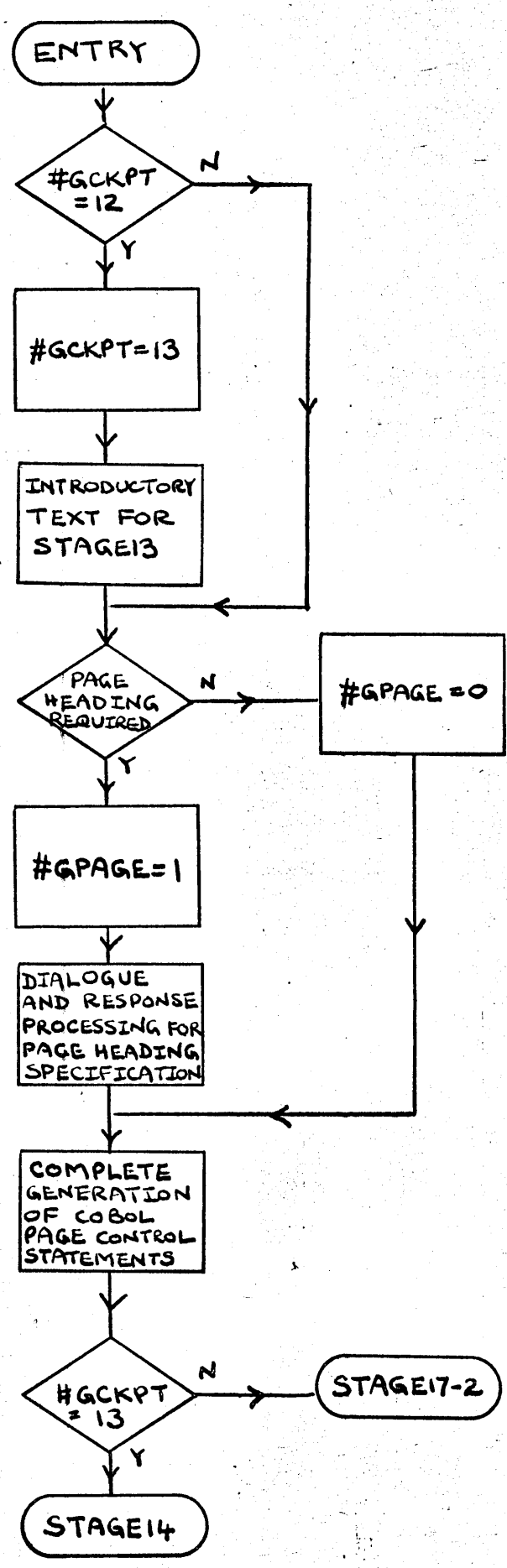


The STAGE13 macro carries out the dialogue with the user in which he may, if he desires, specify a page heading to appear at the top of each report page after the title page, if present.

Since the page heading is optional not all the subfiles shown in the above diagram may be used during the execution of the macro.

A sample of the Stage 13 dialogue is shown in Section 13 of Appendix IX and the outline processing is illustrated in Figure 7.24.

Figure 7.24 Outline processing for the STAGE13 macro



7.21.1 STAGE13 macro processing notes

1. The normal method of entry is from the STAGE12 macro, but entry may also be from the STAGE17-1 macro.

2. #GCKPT, the checkpoint variable, is used to determine the method of entry and, on completion, the next macro in the chain.

3. The introductory text which describes the page heading facility is stored in the DIAL13 subfile. The full text is output only if sequence break headings may follow the page heading (i.e. if #GNKEY > 1). The introductory text is not printed if the macro is entered from the STAGE17-1 macro.

4. Global variable #GPAGE is used to indicate whether or not a page heading is specified.

5. The LABELTABLE subfile (Appendix V Section 8) is used during the validation of line format specifiactions, but only if they contain label characters.

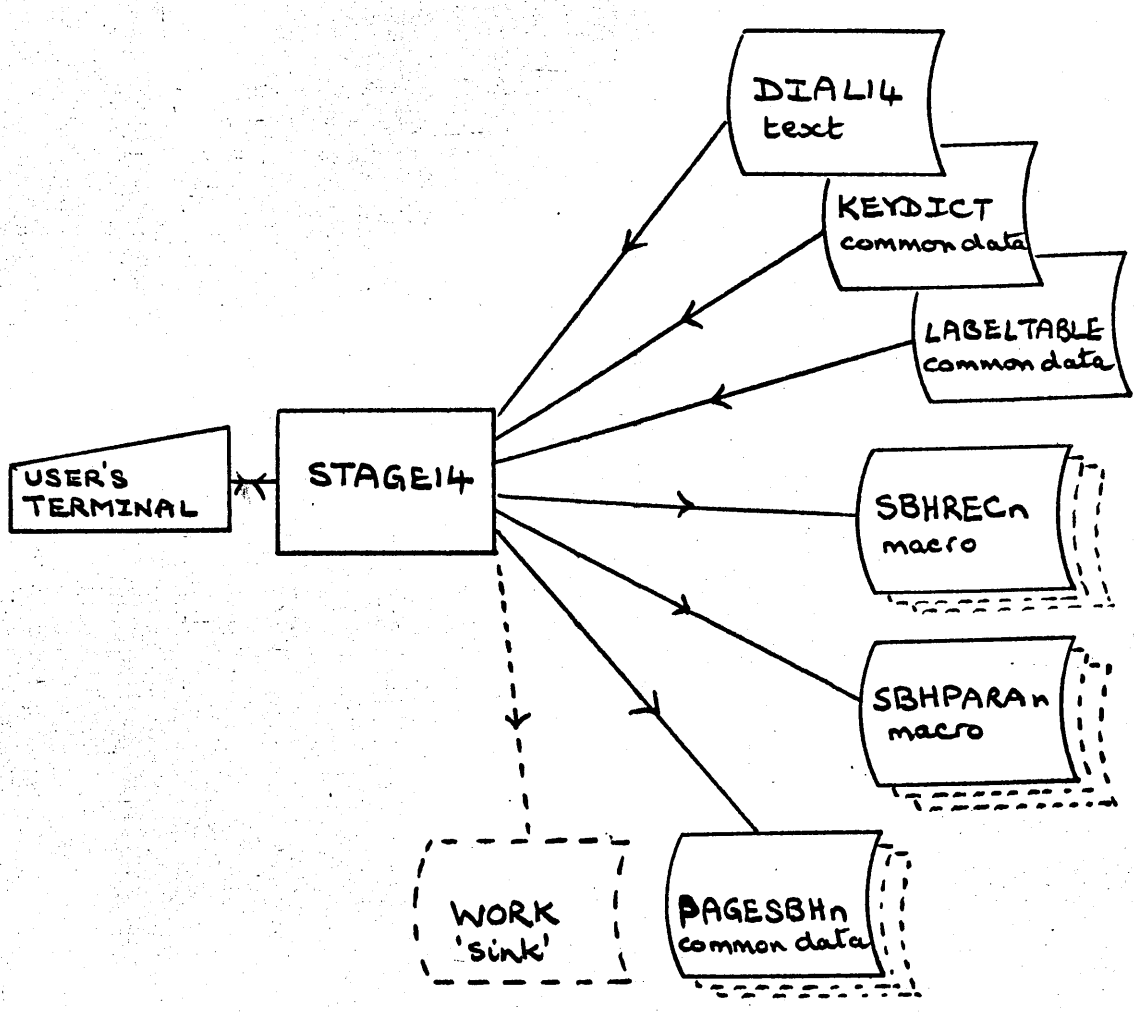
6. Statements for the PHEADREC macro are generated only if a page heading is specified. Z-PAGE-1, Z-PAGE-2, etc are used as the level 01 line-names in the macro body.

7. All seven field types are permitted in a page heading line. Particulars of the identification, validation and level 02 statement generation are given in Appendix VII (Section 18).

8. The PHEADPARA macro is always generated. Its body contains COBOL statements destined for the Z-PARA-PAGE paragraph (See Appendix VII Section 21 for macro details).

9. The PAGEHEAD subfile is recorded only if a page heading is specified. The subfile format details are given in Section 9 of Appendix V. -

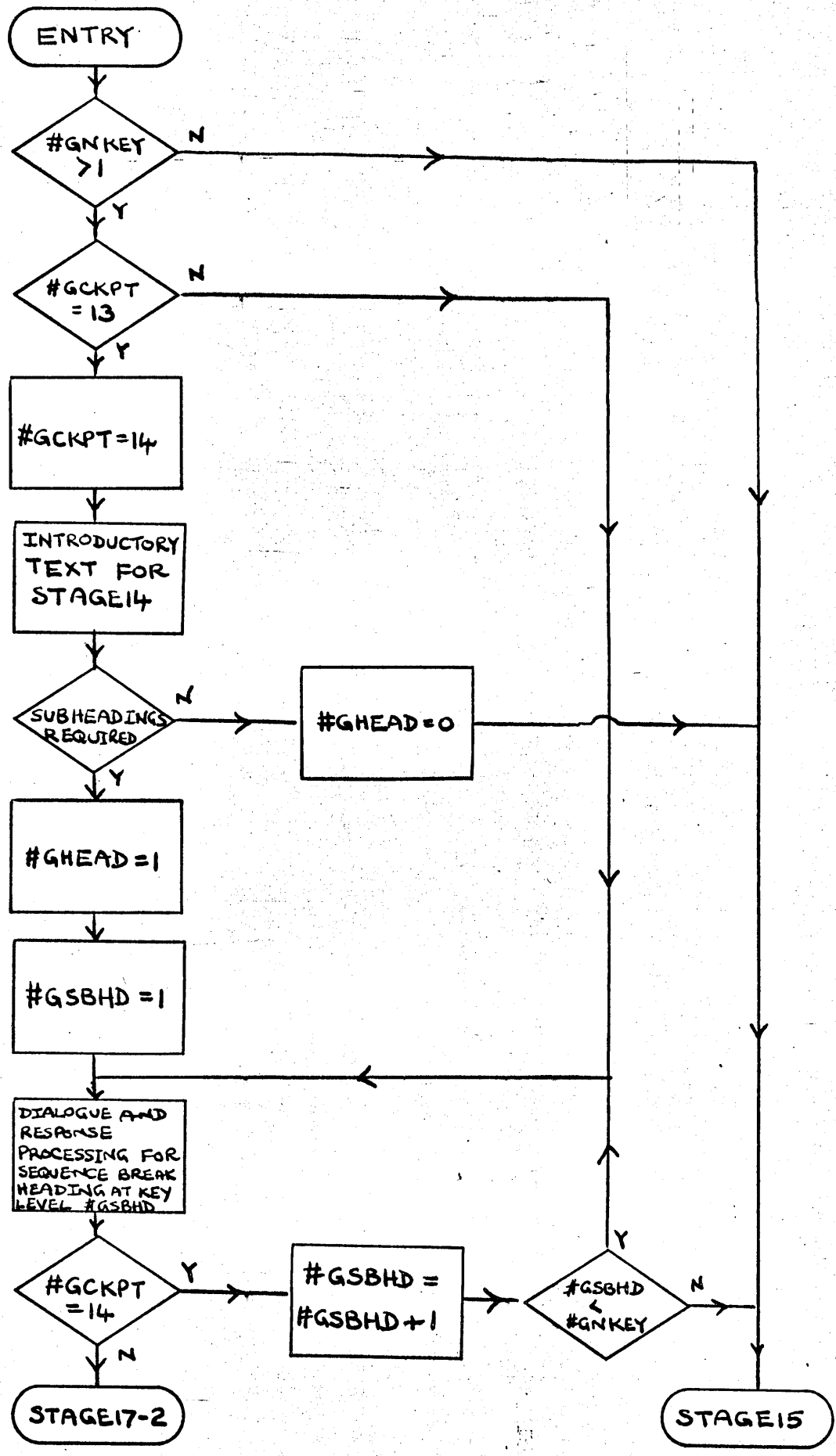
7.22 STAGE 14 - SEQUENCE BREAK HEADING SPECIFICATION



If the user's data is sequenced on more than one key domain the STAGE14 macro carries out the dialogue which invites the user to specify sequence break headings for his report ouput. Sequence break headings may be specified for each key level except the minor key. Only if the option is exercised are the output subfiles used. Separate output subfiles are used for each key level which is denoted by n in the above diagram and in the following text.

A sample of the Stage 14 dialogue is included in Section 14 of Appendix IX and the outline processing is illustrated in Figure 7.25.

Figure 7.25 Outline processing for the STAGE14 macro



7.22.1 STAGE14 macro notes

1. The macro is normally entered from STAGE13, but may also be entered from STAGE17-2.

2. Global variable #GCKPT is used to determine the method of entry and hence, on completion, the next macro in the chain.

3. Global variable #GHEAD is used to indicate whether or not sequence break headings have been specified.

4. When entered normally, sequence break headings are specified in major to penultimate minor key order. The current key level is indicated by #GSBHD. When the alternative method of entry is used a single value for #GSBHD is set in the STAGE17-2 macro.

5. The introductory text for the stage is output from DIAL14 only if the macro is entered normally.

6. The KEYDICT subfile (Appendix V Section 5) is used to associate a key name with the current key level for dialogue purposes.

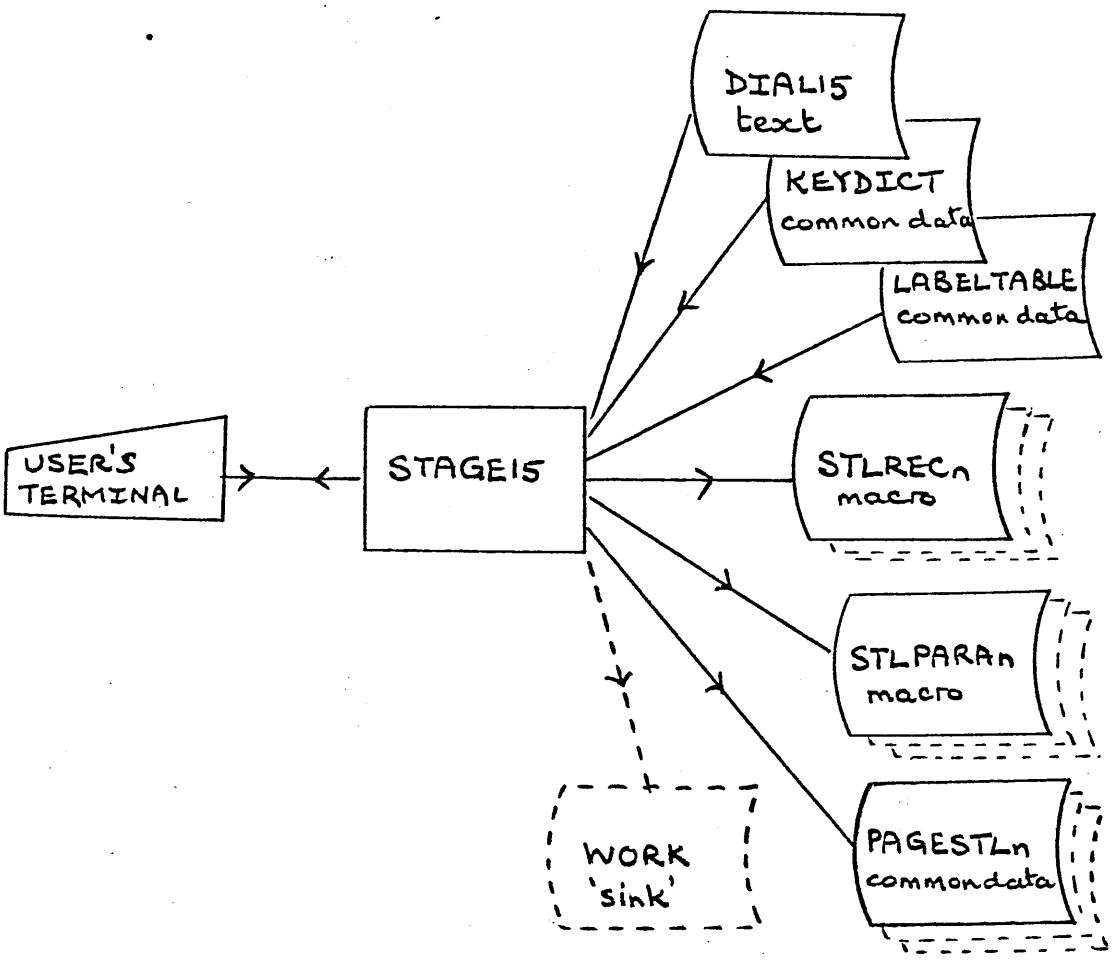
7. The line-names used in level 01 statements generated for the SBHRECn macro are Z-HEADn-1, Z-HEADn-2 etc, where n is the current key level.

8. The LABELTABLE subfile (Appendix V Section 8) is used in the validation of the line specification formats which may include only field types described in Sections 18.1 to 18.4 of Appendix VII.

9. The COBOL statements generated in the body of the SBHPARAn macro are destined for the Z-HEADn-WRITE paragraph. (See Appendix VII Section 22 for macro details.)

10. Format details for the PAGESBHn common data subfiles are given in Appendix V (Section 9).

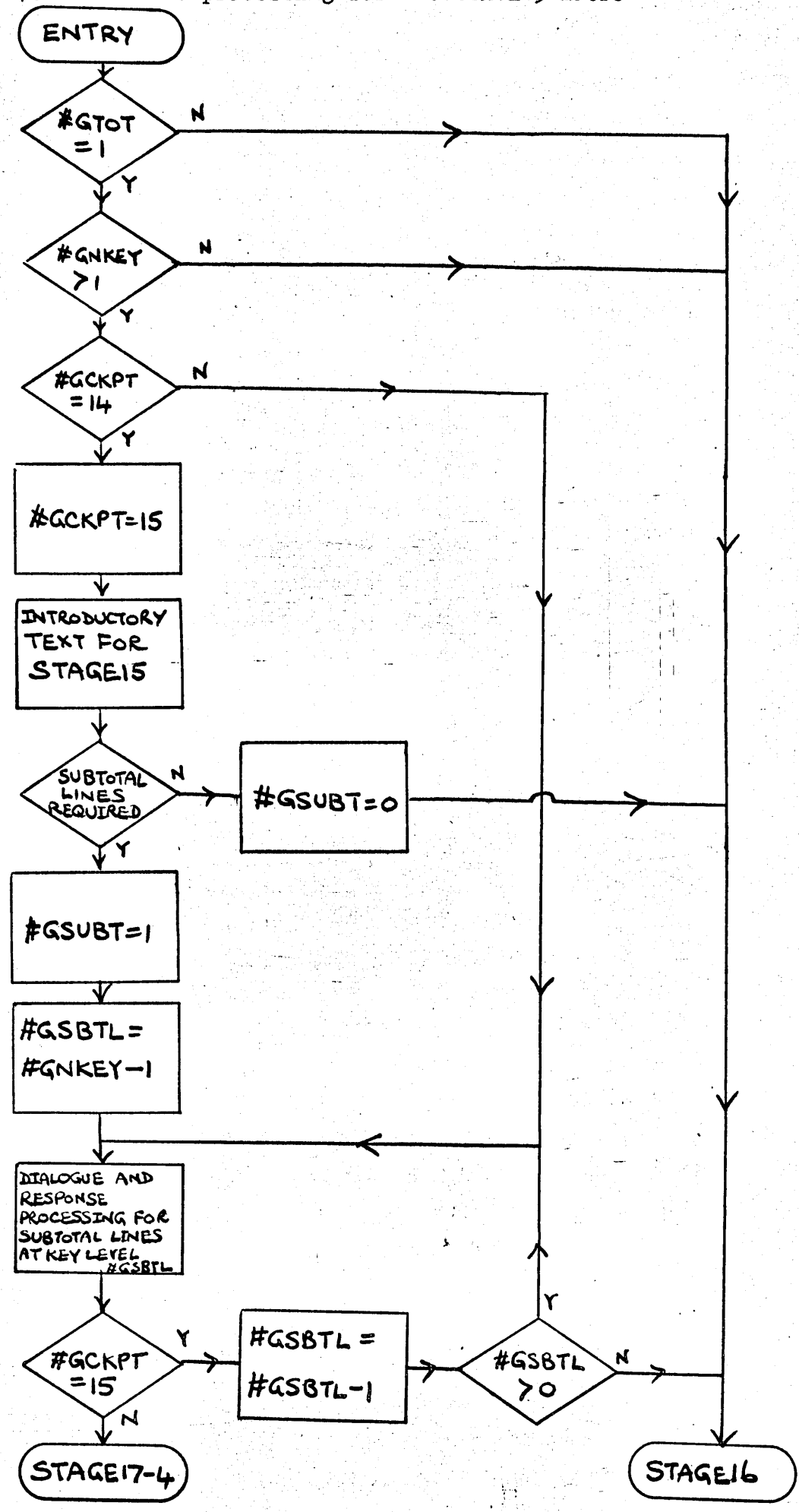
7.23 STAGE 15 - SUBTOTAL LINE(S) SPECIFICATION



Only if the user availed himself of the totalling facility offered in Stages 4 and 5, i.e. if #GTOT = 1, and the data is sequenced on more than one key, i.e. #GNKEY > 1, does the STAGE15 macro invite the user to specify formats for subtotal lines. Subtotal line formats may be specified for each key level except the minor key. Output subfiles are used only if the option is exercised, in which case separate subfiles are used for each key level. The key level is denoted by n in the above diagram and in the following text.

The KEYDICT and LABELTABLE subfiles (Appendix V Sections 5 and 8) are used in the same way as in the STAGE14 macro. Section 15 of Appendix IX contains a sample of the Stage 15 dialogue and Figure 7.26 illustrates the outline processing.

Figure 7.26 Outline processing for the STAGE15 macro



7.23.1 STAGE15 macro notes

1. The macro is normally entered by chaining from the STAGE14 macro, but may also be entered from macro STAGE17-4.

2. The method of entry and, on completion, the next macro in the chain is determined from global variable #GCKPT.

3. Global variable #GSUBT is used to indicate whether or not subtotal lines are specified.

4. When entered normally subtotal lines are specified in penultimate minor to major key order. Global variable #GSBTL is used to indicate the current key level. When the alternative method of entry is used a single value for #GSBTL is set in STAGE17-4.

5. The introductory text from the DIAL15 subfile is only output if the macro is entered normally.

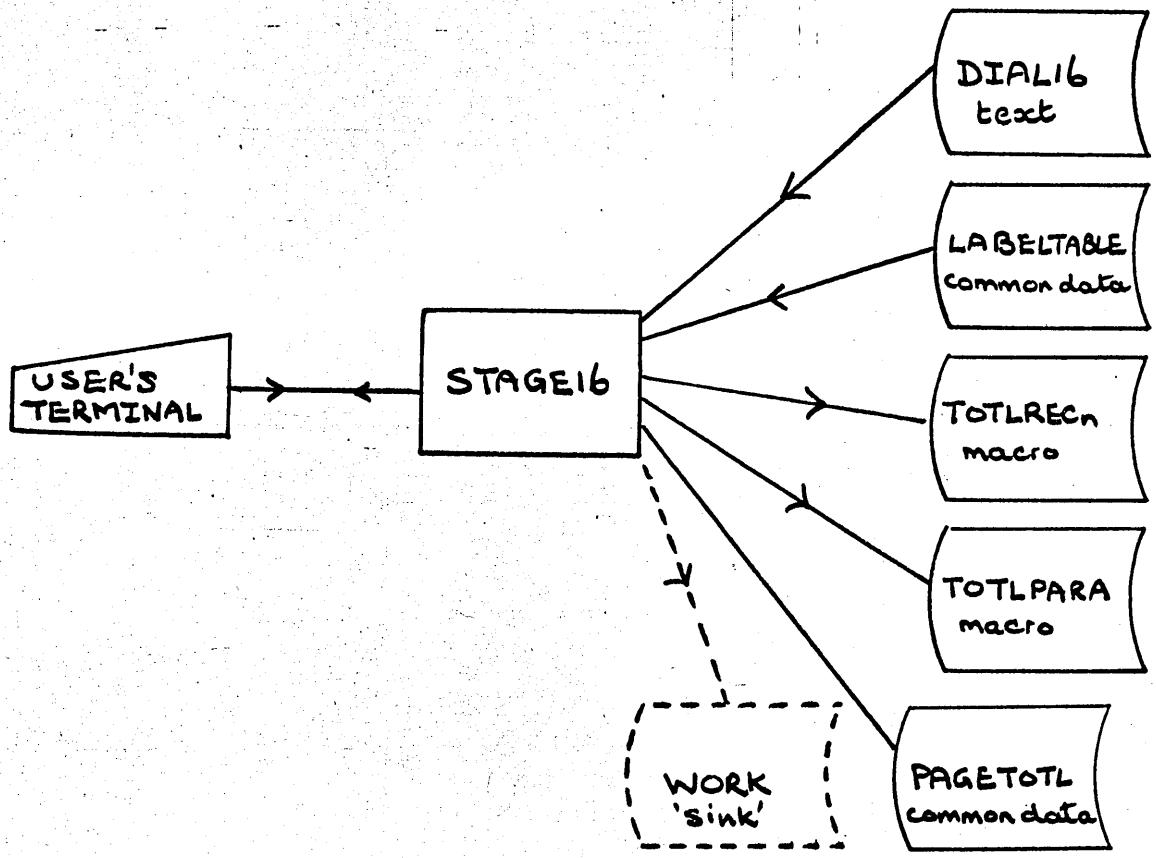
6. The line-names used in the level 01 statements generated for the STLRECn macro are Z-SUBTOTALn-1, Z-SUBTOTALn-2, etc.

7. Only the field types described in Sections 18.1 to 18.4 of Appendix VII may be included in subtotal line format specifications.

8. The COBOL statements generated in the body of the STLPARAn macro are destined for the Z-TOTALn-WRITE paragraph. (See Section 23 of Appendix VII for macro details.)

9. Format details for the PAGESTLn common data subfiles are given in Appendix V (Section 9).

7.24 STAGE 16 - TOTAL LINE(S) SPECIFICATION

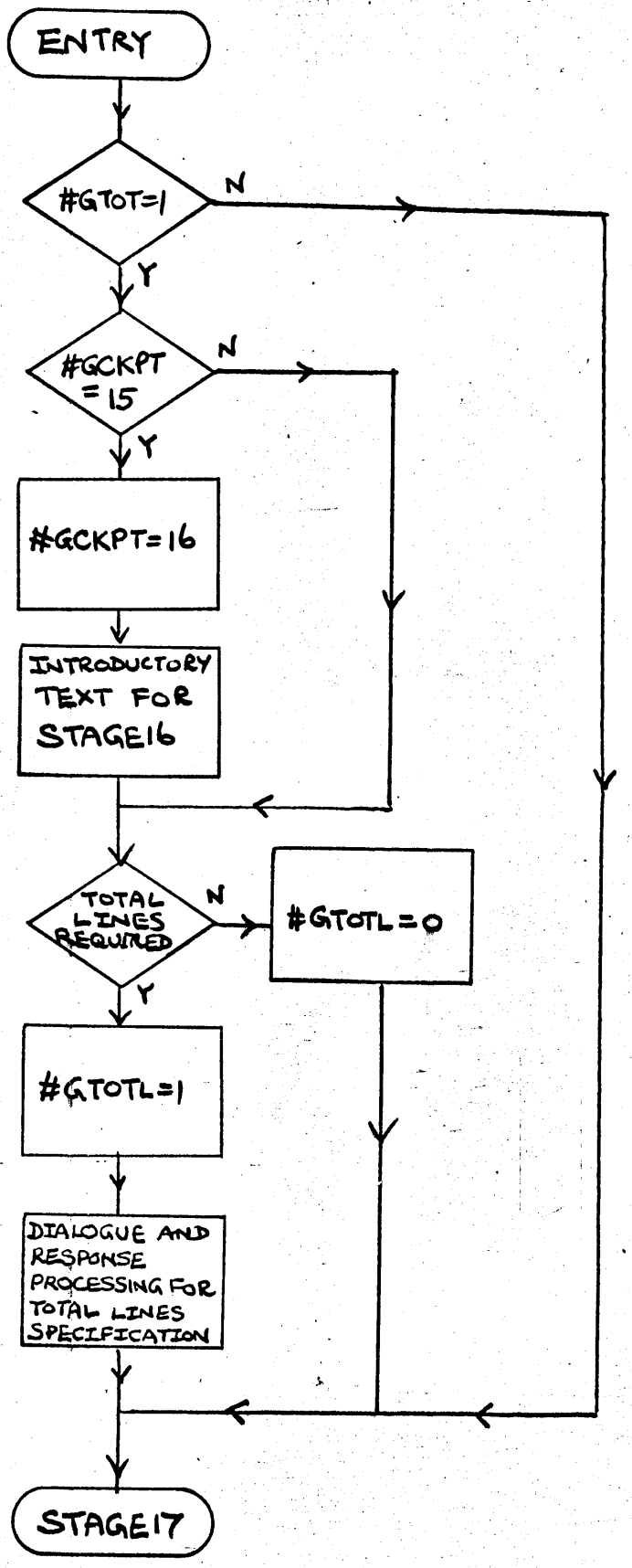


Only if the user took advantage of the totalling facility offered in Stages 4 and 5, i.e. if global variable #GTOT is equal to 1, does the STAGE16 macro invite the user to specify line formats for total lines.

The output subfiles are written only if total lines are specified for the report.

A sample of the Stage 16 dialogue is included in Section 16 of Appendix IX and the outline processing is illustrated in Figure 7.27.

Figure 7.27 Outline processing for the STAGE16 macro



7.24.1 STAGE16 macro notes

1. The STAGE16 macro is entered by chaining from the STAGE15 macro or from the STAGE17-5 macro.

2. Checkpoint variable #GCKPT is used to determine the method of entry. Only when entry is from STAGE15 is the introductory text from the DIAL16 subfile output to the user.

3. Global variable #GTOTL is used to record whether or not total lines are specified.

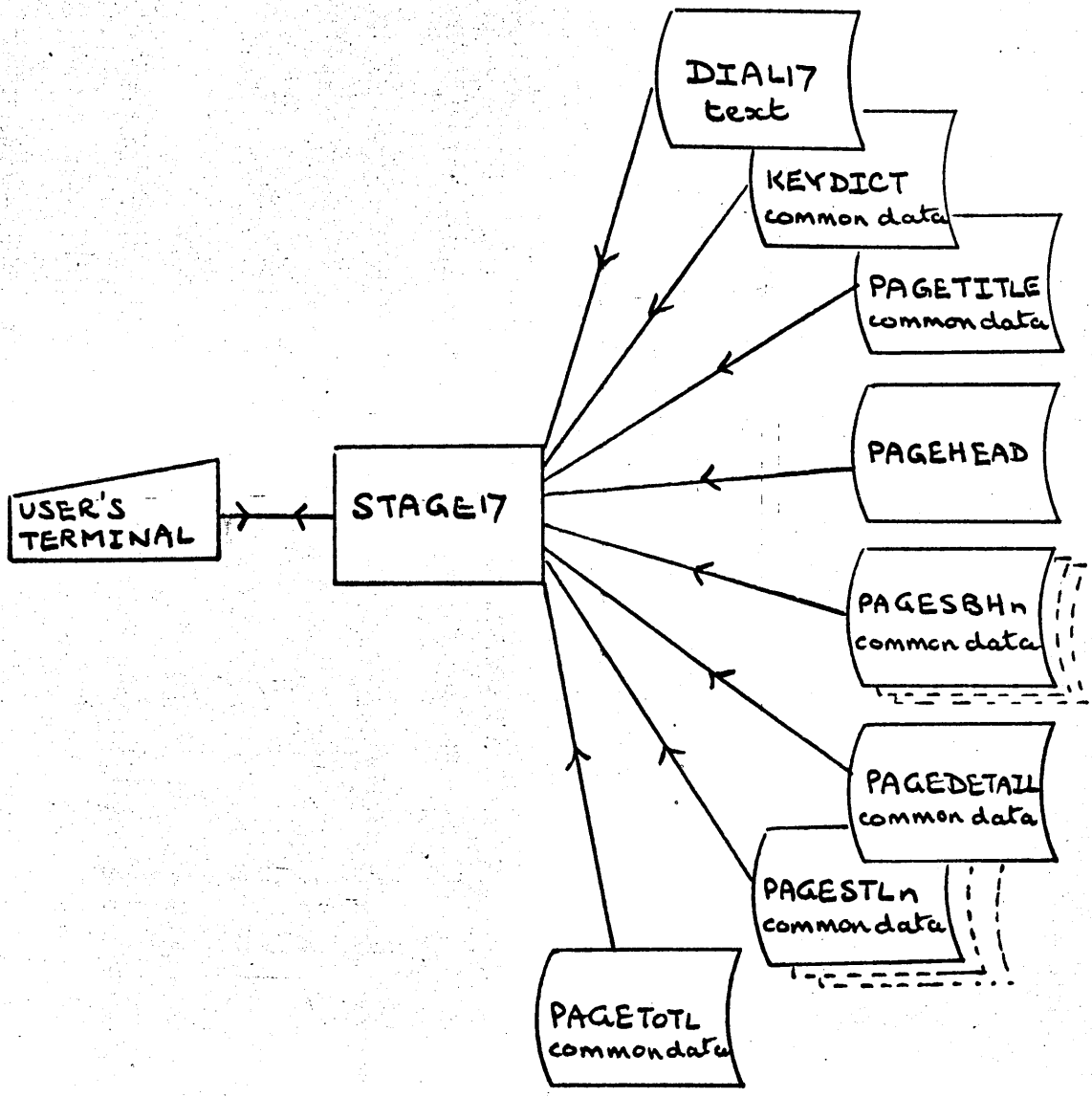
4. The line-names used in the level 01 statements generated for the TOTLREC macro are Z-TOTAL-1, Z-TOTAL-2, etc.

5. The LABELTABLE subfile (Appendix V Section 8) is used during the validation of line format specifications only when they contain label characters. Only the field types described in Appendix VII Sections 18.1 to 18.4 may be used.

6. The COBOL statements generated for the body of the TOTLPARA macro are destined for the Z-TOTALO-WRITE paragraph. (See Section 24 of Appendix VII for macro details.)

7. Format details for the PAGETOTL subfile are given in Appendix V (Section 9).

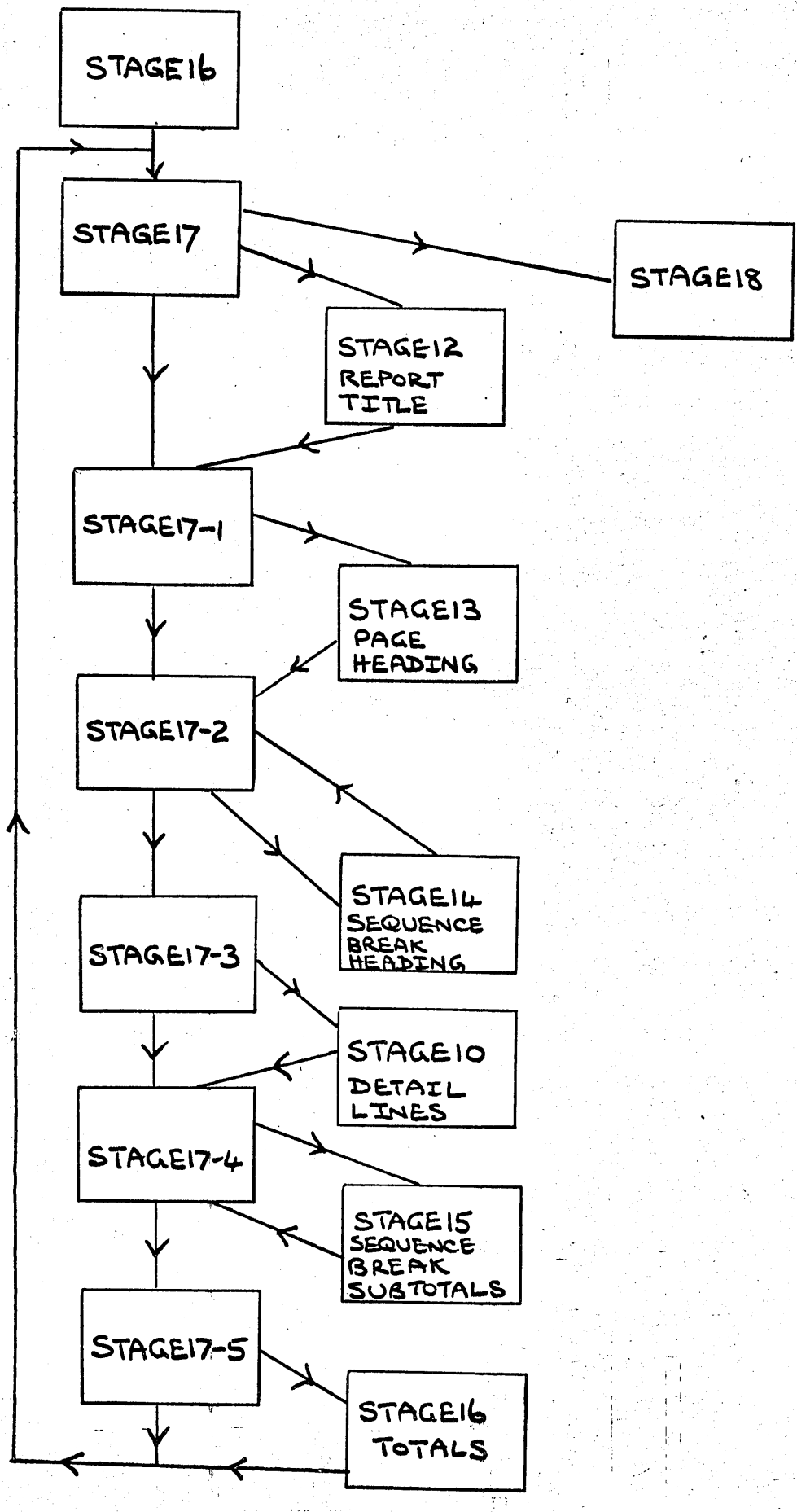
7.25 STAGE 17 - SAMPLE PAGE DIALOGUE



The purpose of the Stage 17 problem specifying dialogue is to give the user the opportunity to view a stylized sample of a report page based on the format specifications which he entered during the earlier stages of the dialogue. Should the composite page prove displeasing or if the user's design cannot be accommodated within the number of lines chosen as the maximum for a report page, the user is invited to redesign the formats for the report output categories.

In order to be able to enter and return from the format specifying macros of the previous stages, six macro definitions are required for Stage 17. The Stage 17 macro linkages originally

Figure 7.28 Macro linkages for Stage 17

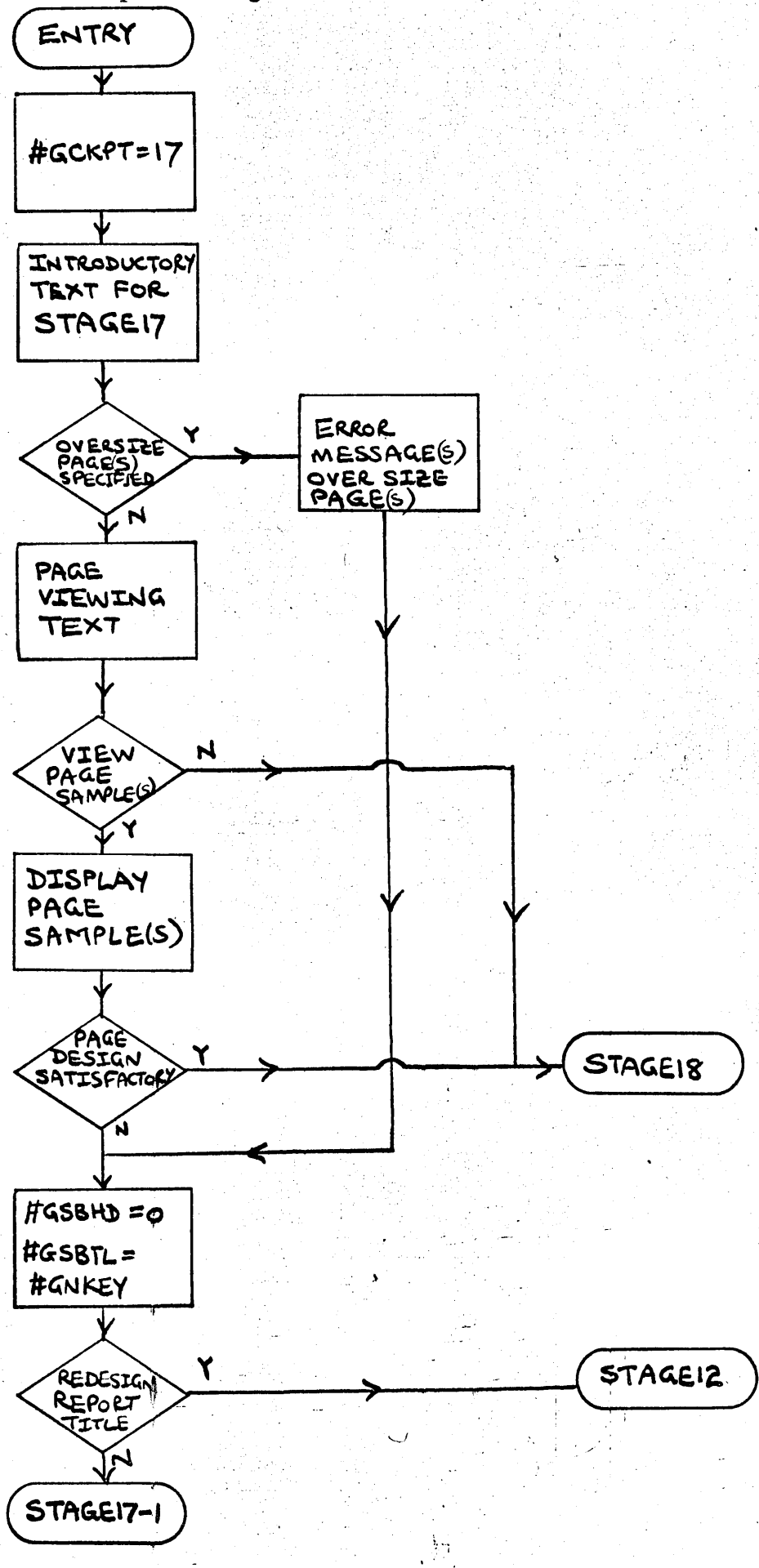


illustrated in Figure 7.2 are redrawn in Figure 7.28 with the linkages to the HELP macro omitted. Figures 7.29 to 7.34 and the accompanying notes outline the processing carried out by the six Stage 17 macros.

In addition to the DIAL17 text subfile and the key dictionary subfile KEYDICT, all the subfiles with the PAGE name prefix, written in Stages 10, 12, 13, 14, 15 and 16, are used when building up the sample report pages.

A stylized report page is included in the sample of Stage 17 dialogue which appears in Section 17 of Appendix IX.

Figure 7.29 Outline processing for the STAGE17 macro



7.25.1 STAGE17 macro notes

1. If any of the conditions set out in Section 25 of Appendix VII for the combinations of report output categories to be accomodated on a report page are not satisfied, an oversize page is deemed to have been specified. In this case a meaningful error message is output on the user's terminal and he is asked to redesign the page layout.

2. The data in the subfiles with the name prefix PAGE (Appendix V Section 9) is used to form the page samples displayed on the user's terminal. The title page, if specified, consists of the line records from the PAGETITLE subfile and sufficient blank lines to make up a full length page. The sample report page consists of one copy of the line records for each category of output specified by the user. The line records for the detail category are, if space permits, repeated several times to fill out the sample page to near maximum length. The output categories appear in their natural order, i.e. page heading, sequence break headings, detail lines, sequence break subtotals and totals. When the page length is too short to accomodate subtotal and total categories these are made to appear on a separate headed page or pages. In all cases where line records from the PAGE name subfiles begin with the greater than character (>), this is replaced by a blank before the line is output for the user.

3. Global variables #GSBHD and #GSBTL are initially set equal to zero and #GNKEY respectively. These variables are used to indicate the current key level when sequence break headings and subtotals output formats are respecified (7.22 and 7.23).

4. The first report output category which the user is invited to redesign is the report title.

Figure 7.30 Outline processing for the STAGE17-1 macro

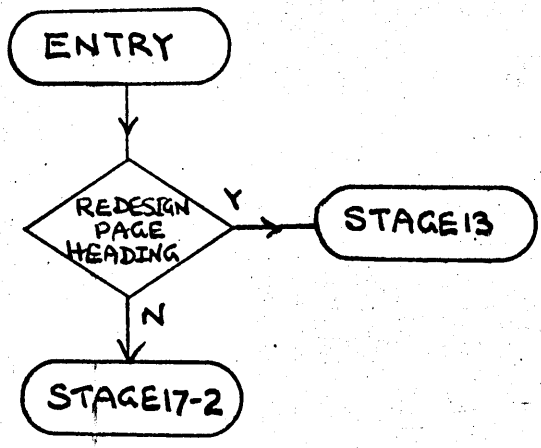
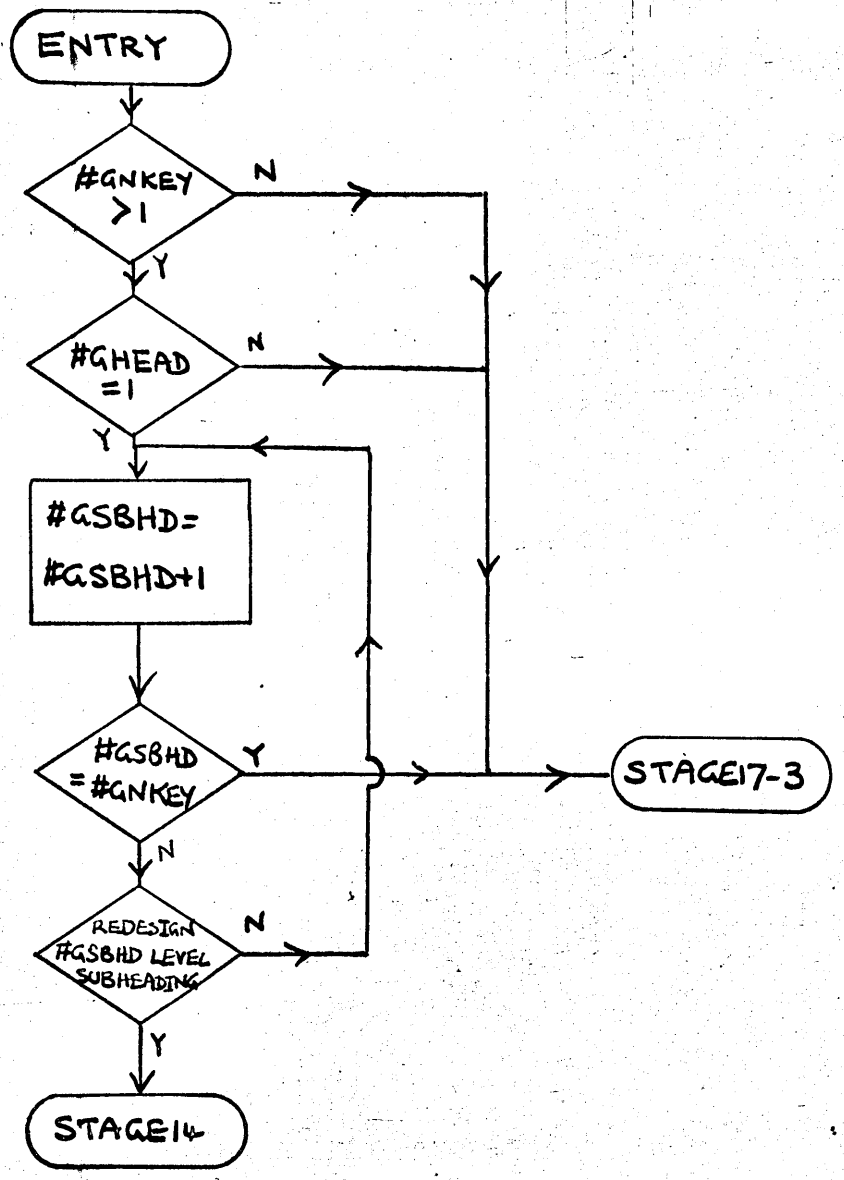


Figure 7.31 Outline processing for the STAGE17-2 macro



7.25.2 STAGE17-1 macro notes

The STAGE17-1 macro asks the user to specify whether or not he wishes to redesign the page heading. If the reply is 'yes' control is passed to the STAGE13 macro, otherwise control passes to the STAGE17-2 macro.

7.25.3 STAGE17-2 macro notes

1. If the number of sequence keys in the user's data (#GNKEY) is greater than 1 and the user had previously specified sequence break headings, i.e. #GHEAD equals 1, he is given the opportunity to redesign their layouts. Otherwise control pasees to the STAGE17-3 macro.

2. The user is invited to redesign the sequence break heading for each key domain in major to penultimate minor key order. Global variable #GSBHD is used to denote the key level of the current sequence break heading. This variable is initialised to zero in the STAGE17 macro and is incremented in the dialogue processing loop of this macro. #GSBHD is also used to look up the name of the current key domain in the KEYDICT subfile. Control passes to the STAGE14 macro if the user accepts the invitation to redesign a specific sequence break heading.

3. When all sequence break headings have been offered to the user, i.e. #GSBHD equals #GNKEY, control passes to the STAGE17-3 macro.

Figure 7.32 Outline processing for the STAGE17-3 macro

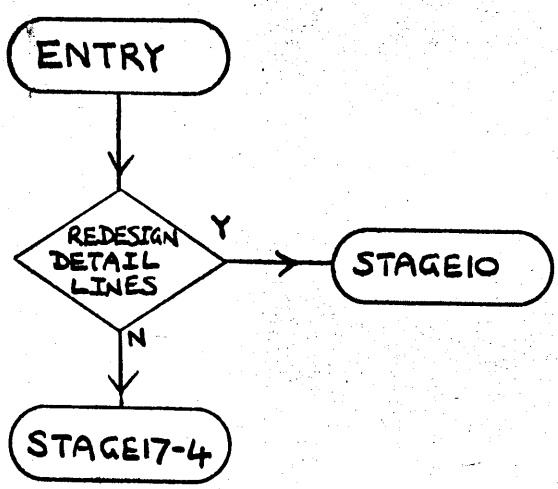
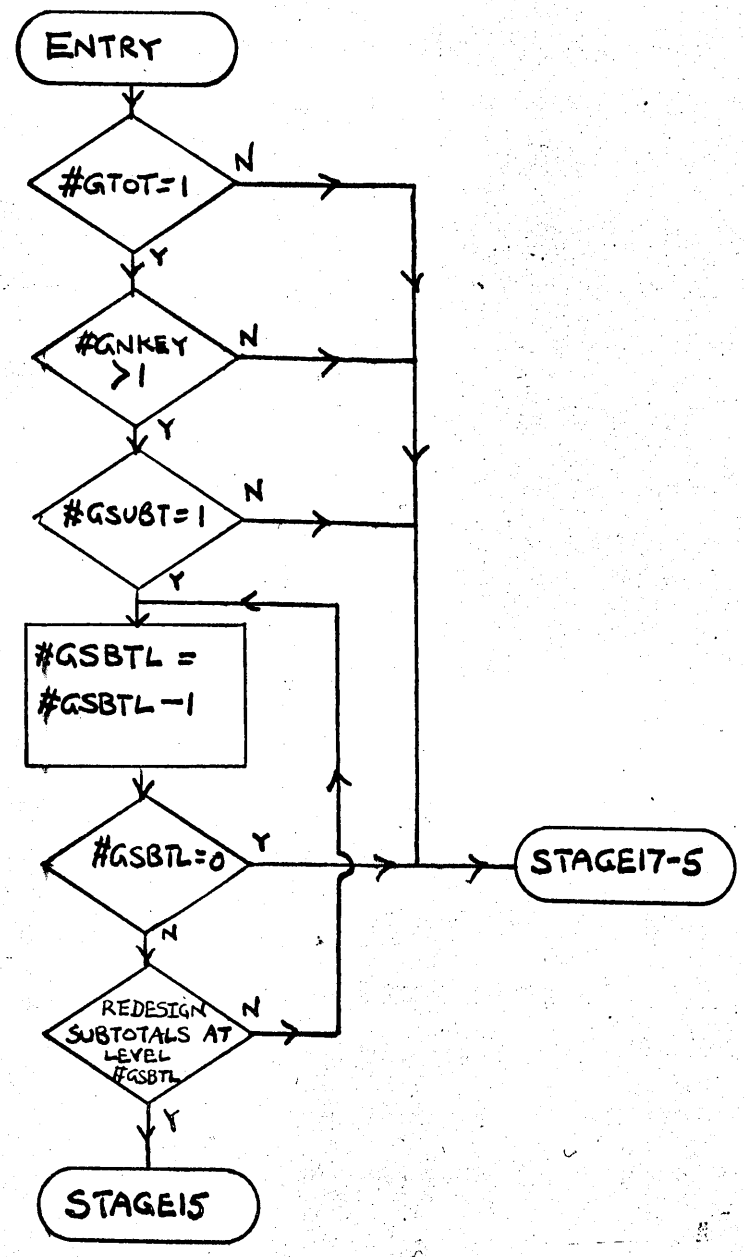


Figure 7.33 Outline processing for the STAGE17-4 macro



7.25.4 STAGE17-3 macro notes

The STAGE17-3 macro asks the user if he wishes to redesign his detail line formats. If the reply is 'yes', control passes to the STAGE10 macro, otherwise control is passed to the STAGE17-4 macro.

7.25.5 STAGE17-4 macro notes

1. If the following three conditions are satisfied the user is given the opportunity to redesign the sequence break subtotal layouts, otherwise control passes directly to the STAGE17-5 macro:

Totalling facility invoked (#GTOT = 1).

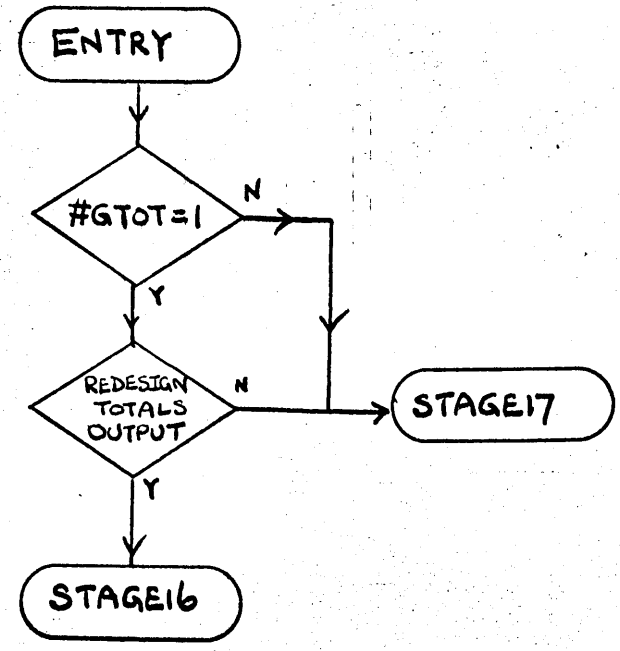
There is more than one sequence key in the user's data (#GNKEY > 1).

Sequence break subtotals have previously been specified (#GSUBT = 1).

2. The user is invited to redesign the sequence break subtotals output for each key domain in penultimate minor to major key order. Global variable #GSBTL is used to denote the key level of the current sequence break output. This variable, initialised to the value of #GNKEY in the STAGE17 macro, is decremented in the dialogue processing loop. It is also used to look up the name of the current key domain in the KEYDICT subfile. Control passes to the STAGE15 macro if the user accepts the invitation to redesign the subtotal output for a sequence break on a specific key.

3. When all the sequence break subtotal outputs have been offered, i.e. #GSBTL equals 1, control passes to the STAGE17-5 macro.

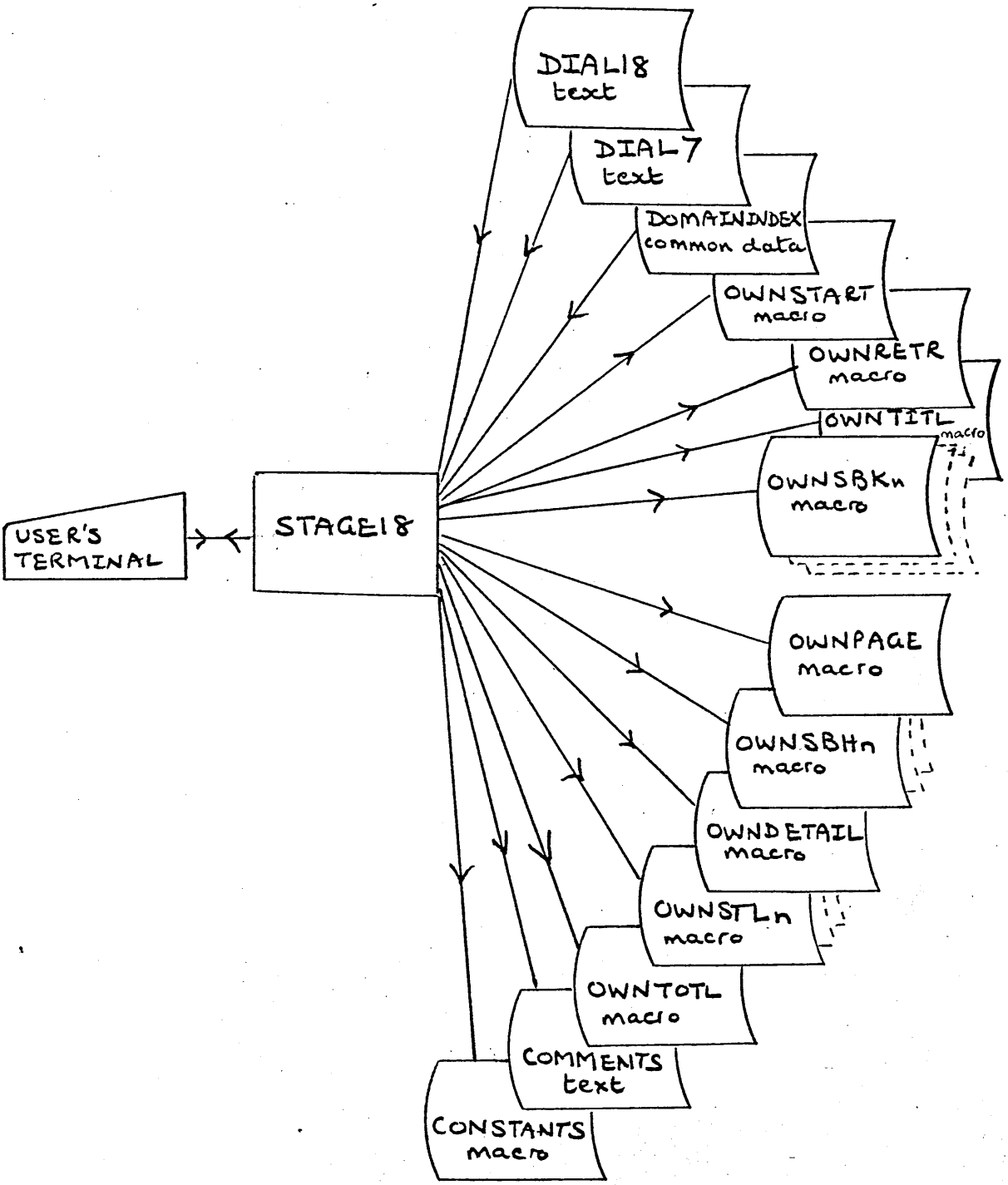
Figure 7.34 Outline processing for the STAGE17-5 macro



7.25.6 STAGE17-5 macro notes

If the totalling facility was invoked, i.e. #GTOT is equal to 1, the STAGE17-5 macro invites the user to redesign his totals output. If he accepts the offer control passes to the STAGE16 macro, otherwise it is passed to the STAGE17 macro where the validity on any layout changes can be assessed.

7.26 STAGE 18 - OWN CODE PROCESSING



The major function of the STAGE18 macro is to explain to the user the own code processing facilities and, if required, to carry out the dialogue in which he specifies his requirements. Because they require relatively few macro-time statements the following three subsiduary tasks are included in order to avoid yet another stage:

1. Invite the user to enter comments on the problem specifying stages.

2. Generate statements for the CONSTANTS macro definition subfile which is used during the generation of the complete COBOL program.

3. Instruct the user how to exit from the PG/2 macro processor.

The instructional text located in the DIAL18 subfile describes the use of the five own code statements ADD, SUBTRACT, DIVIDE, MULTIPLY and MOVE (6.6.4). As the execution of each own code statement may be conditional some of the text in the DIAL7 subfile may be used if the user wishes to be reminded of how to specify conditions.

For each point in the COBOL report program where own code processing may be inserted there exists a macro definition subfile with OWN as the name prefix. Further details of the subfile associated with each processing point is given in Appendix VII (Section 26). The statements for the macros at the selected own code processing points are generated during this stage. The body of each macro contains the COBOL statements generated from the information supplied in the user's own code specifiactions.

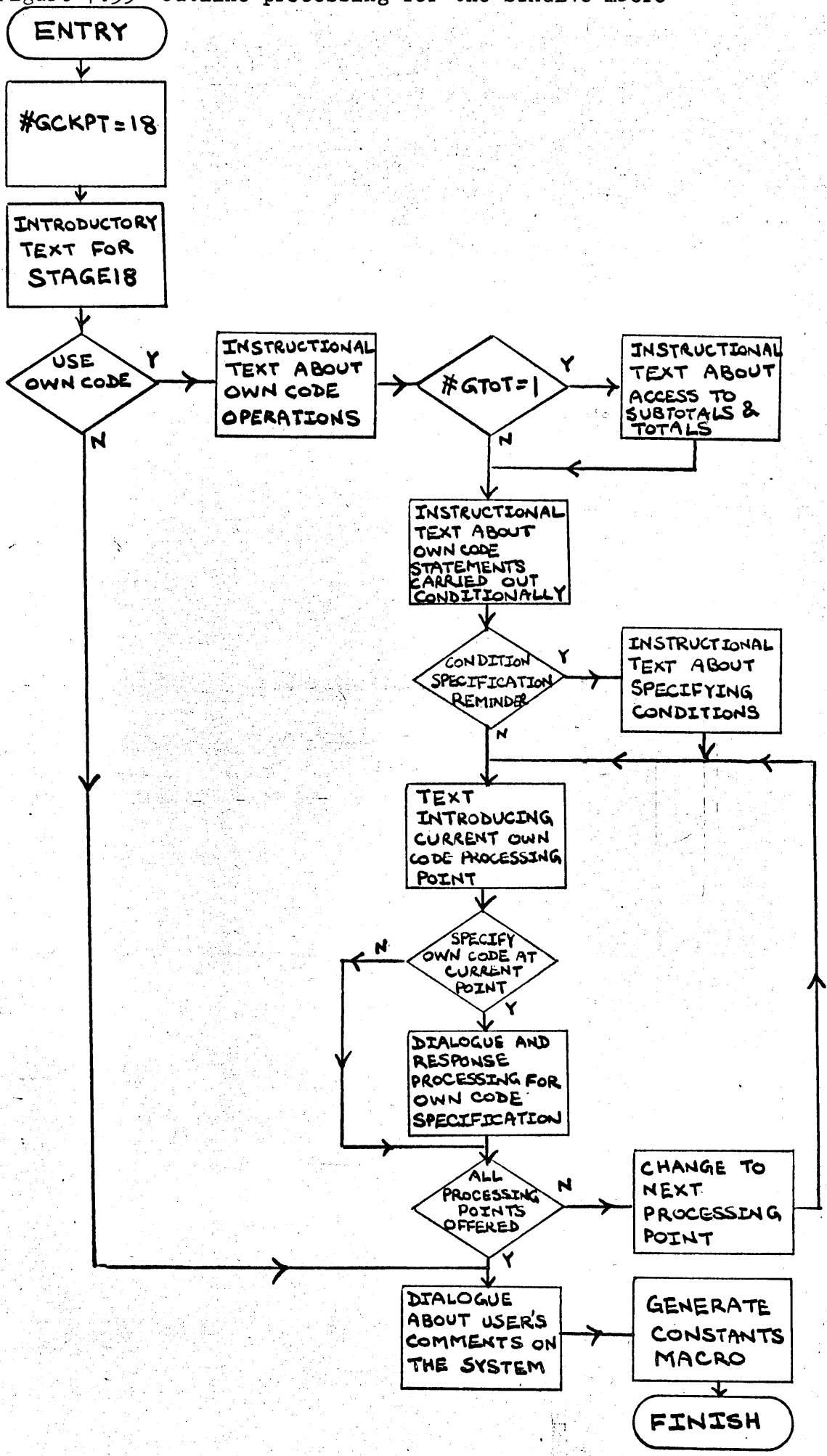
The DOMAININDEX subfile is referenced during the validation of the user's own code and condition statements, if any.

The COMMENTS subfile is a text subfile to which any comments the user may choose to enter about the COBOL generating system are appended. The subfile contents are available to those maintaining the COBOL generating system.

The CONSTANTS macro definition subfile is used to pass values of string and global variables between the problem specifying phase and the COBOL program generating phase.

A sample of the Stage 18 dialogue is included in Section 18

Figure 7.35 Outline processing for the STAGE18 macro



of Appendix IX and the outline processing of the STAGE18 macro is illustrated in Figure 7.35.

7.26.1 STAGE18 macro notes

1. Copies of the condition specifying and validation routines are included in the STAGE18 macro (Appendix VII Sections 15.1 and 15.2).

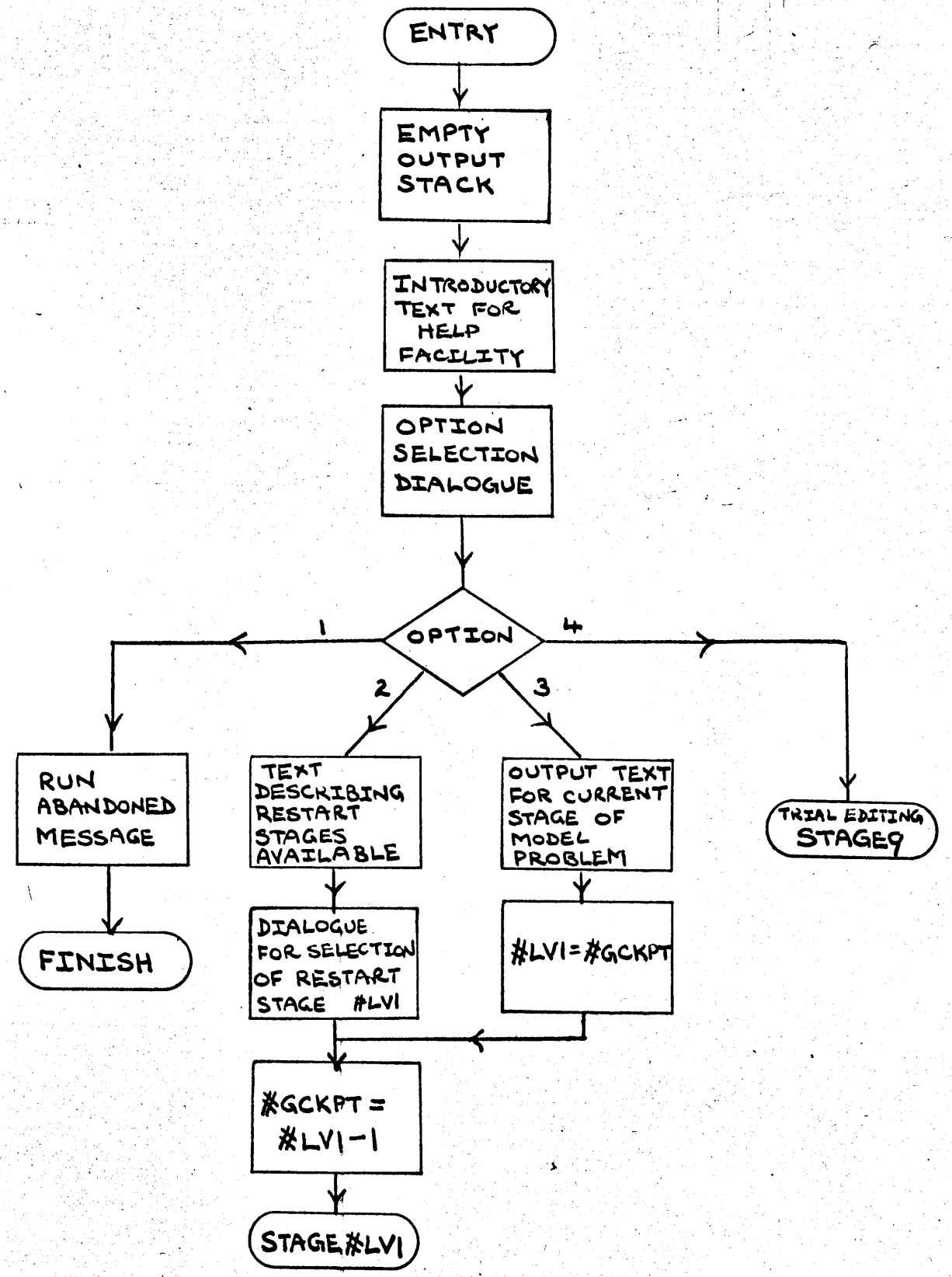
2. The identification and validation of own code statements is described in Section 27 of Appendix VII together with details of the generation of the equivalent COBOL statements.

3. The general form of the OWN name prefix macros generated in this stage is shown in Section 26 of Appendix VII.

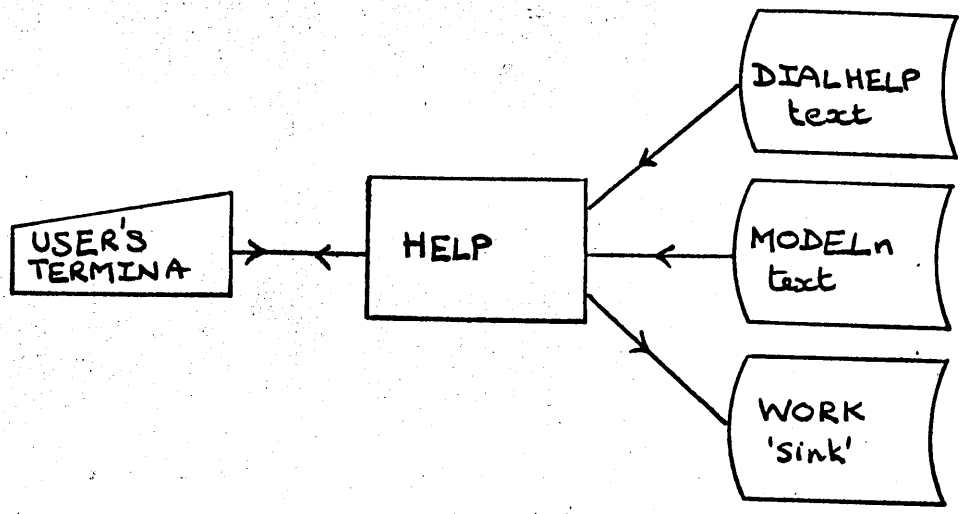
4. Section 28 of Appendix VII gives details of the variables whose values are recorded in the CONSTANTS macro and also the general form of this macro.

5. If the totalling facility was invoked in Stages 4 or 5, i.e. if global variable #GTOT is equal to 1, the user is instructed how to access the subtotals and totals in his own code statements.

Figure 7.36 Outline processing for the HELP macro



7.27 HELP MACRO



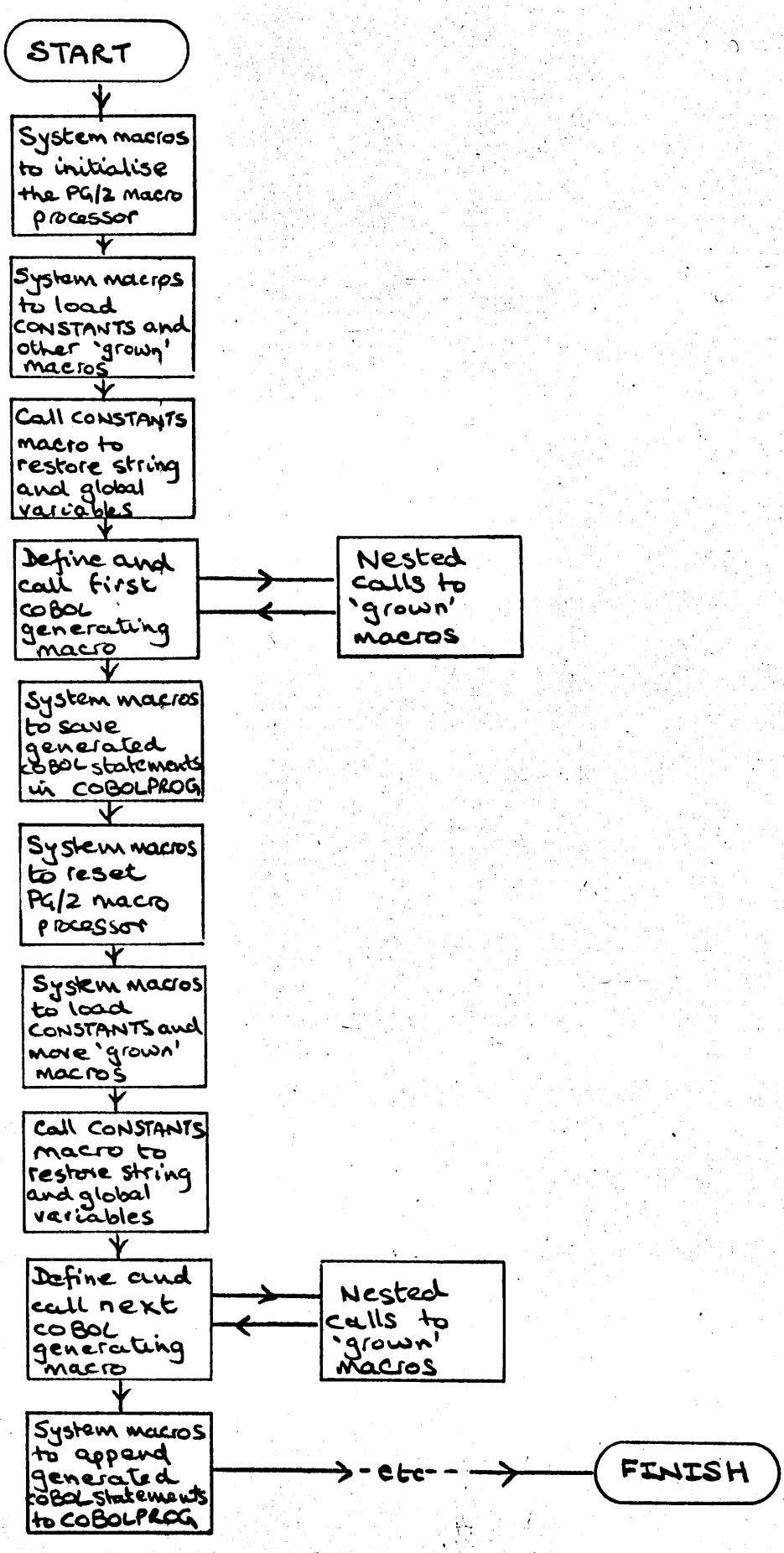
The HELP macro carries out a dialogue with the user in which the 'help' facilities are described and the selected option implemented. The detection of a plea for help and the facilities available are described in Section 6.2.3. The HELP macro linkages are illustrated in Figure 7.2 and the outline processing is shown in Figure 7.36.

One and sometimes two text subfiles are used as input to the HELP macro. The DIALHELP subfile contains the text describing the help facilities. The other text subfile MODELn, where n is the current stage number contained in global variable #GCKPT, is used only if the option to view the dialogue for the corresponding stage of the model problem is selected.

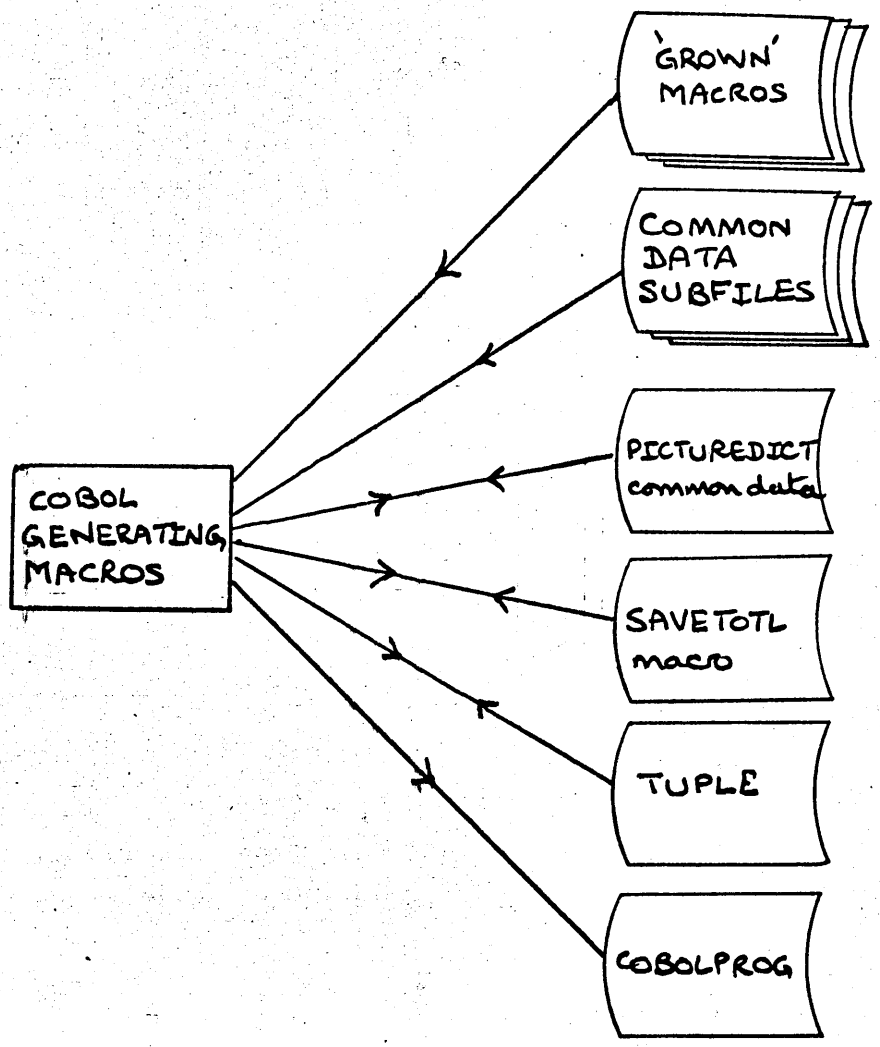
The WORK subfile is used as a 'sink' in which to empty the PG/2 macro processor output stack of any statements generated in the stage from which the plea for help was made.

The processing details for the HELP macro are given in Section 29 of Appendix VII and a listing of the partially developed macro is included in the separate folder (Item 28).

Figure 7.37 Outline structure of the PG/2 macro processor input file for the generation of a complete COBOL report program



7.28 GENERATION OF A COMPLETE COBOL PROGRAM



In the process of generating a complete COBOL report program the program is built up by synthesising a very large number of fragments of code (rather like conventional compiler code generation). This is in contrast with the process of generating a FORTRAN program [5] which consisted of 'filling out a framework'.

During the problem specifying dialogue the user supplied all the information necessary to generate the complete COBOL program. This information was recorded in the common data subfiles and the macro definitions which were 'grown' during the various stages of the dialogue. The complete COBOL program can be generated using the PG/2 processor and a prepared input file containing a series of system and COBOL generating macros. Figure 7.37 illustrates

the general form of the PG/2 macro processor input file which causes the complete COBOL program to be generated and filed in the COBOLPROG subfile.

The generation of the complete COBOL program is carried out by a series of COBOL generating macros for the following reasons:

1. A single macro would be too large.

2. The PG/2 stacks are not large enough for all the 'grown' macros to be loaded at the same time.

3. The PG/2 output stack is not large enough to contain the complete COBOL program.

The structure of the COBOL program is partly determined by generator macros and partly by the 'grown' macros. The program listing in Appendix X is annotated to show which statements come from 'grown' macros and which come from the generator macros.

The system macros control the loading of the 'grown' macros, the bodies of which, with the exception of the CONSTANTS macro, contain fragments of COBOL code. The COBOL generating macros make nested calls to the 'grown' macros so that the COBOL code they contain is regenerated in the correct position in the program. In the COBOL generating macros the calls to the 'grown' macros are intersperced between macro-time statements which generate other fragments of code. The information from which these fragments are generated is obtained from the common data subfiles and the values of the string and global variables as set by the CONSTANTS macro.

During the COBOL generating macro which carries out the Data division preliminaries (Appendix VIII Section 3) the common data subfile PICTUREDICT is written and two more macros, TUPLE and SAVETOTL, are 'grown'. They are used to record information and COBOL statements which are required by subsequent COBOL generating macros.

Details of the generation of a COBOL report program for the general case where the user's data is on more than one input file and sequenced on more than one key are given in Appendix VIII. All the data file sequence keys are assumed to be in ascending order and there is no provision for the elimination of duplicate detail lines.

A useful extension would be to amend the generator macros so that they could take advantage of special circumstances, e.g. where only one data file is used or when all the data files are sequenced on one and the same key. The generated program could then be structured to take advantage of the special conditions and so yield simpler COBOL code. Areas where the special conditions prove advantageous include the totalling facility, the matching of input record keys and the detection of sequence key breaks.

A listing of the COBOL program which would be generated for the solution of the model problem described in Section 5.9 is included in Appendix X.

7.29 SUMMARY AND APPRAISAL

The material presented in this chapter and the contents of Appendices V to X demonstrates the feasibility of generating valid COBOL report programs from information gathered in a dialogue with a casual user who is presented with a relational view of his data.

The use of the catalogue enables data access to be controlled and allows the relational view to be presented without burdening the casual user with details of the physical organisation of his data files. Although only basic facilities were developed in the Librarian macros to enable the data base administrator to maintain the catalogue of file descriptions, there is potential for these to be enhanced so that greater use

can be made of the catalogue information.

By carrying out problem specification in foreground mode and relegating the generation of the complete program to background mode, the COBOL generating system contributes to the effective use of computer resources. The segmentation of the problem specifying dialogue into separate stages, each dealing with a different aspect of the report specification and consisting of one or more macros, contributes to the ease with which the system can be maintained and enhanced. Additional features can be implemented by inserting more stages in the dialogue and/or more macros in the chain.

The processing described for the COBOL generating macros and the manually fabricated program show that syntactically correct COBOL can be generated which will produce the report requested in the problem specifying dialogue.

The COBOL report program generating system is large and relies heavily on the use of the PG/2 macro processor subfiles for the storage of macros, instructional text, common data, the generated program and the catalogue of file descriptions. The extensive validation of the user's responses and the relatively low level language of the macro processor are factors which contribute to the volume of coding required to implement the macros. The relatively poor diagnostic facilities of the macro processor (4.8) tend to increase the time required to develop the large macros. The inefficient implementation of the macro-time statements for accessing the subfile records (4.8.2) makes the developed macros 'peripheral limited', while the lack of the stack emptying facility (4.8.1) precludes the complete development of the system beyond the fourth stage of the problem specifying dialogue.

The quality of the generated code compares favourably with

hand coded programs although there is still some scope for improvement. Many of the generated COBOL statements occupy two lines of coding although, if hand coded, they require only one. This is because in the generated statements space is always allowed for data names to consist of 15 characters, the maximum permitted. The speed and efficiency of the COBOL compiler more than compensates for the additional macro-time statements which would be required to improve the elegance of the generated code in this respect.

It would be possible to amend the generation strategy to optimise certain aspects of the generated program. Some examples of where this can be done are given below.

At present the statements for setting up the run time and date items ZTIME and ZDATE are always generated even if these items do not appear in the printed report. Similarly the page number item Z-PAGE-COUNT is generated and incremented even when the report pages are unnumbered. These program inefficiencies can be eliminated by making the generation of the COBOL statements conditional on global variable indicators set during the problem specifying dialogue.

The statements which define and process the Z-IGNORE data item are also generated unconditionally. Ideally, they should be generated only if the user chose to ignore data base inconsistencies in Stage 6 of the problem specifying dialogue, i.e. if global variable #GOPT was set equal to 1.

Another part of the COBOL program which merits further study is the use of the Z-CONTROL-BREAK group. As this group duplicates the sequence key items in the Z-TUPLE group, an investigation into the advantages of making Z-CONTOL-BREAK a subgroup of the Z-TUPLE group would be worthwhile.

The strategy adopted in the Z-FETCH-TUPLE section of the

COBOL program for matching sequence keys of non-master input files relies on the use of the RETAIN option of the CLOSE verb. The RETAIN option is not available for use with files on cards or paper tape, but there is no check to prevent such an error being generated. Attempts to use input files on cards or paper tape can be detected in the STAGE3-1 macro of the problem specifying dialogue. Additional validatory steps can be provided when the checks for data base inconsistencies are made.

The effectiveness of the COBOL generating system can be fully appraised only when a complete operational system is available .

CHAPTER 8

APPRAISAL AND CONCLUSIONS

8.1 INTRODUCTION

In this chapter the various aspects of dialogue based COBOL report program generation are appraised. Areas which can be improved or merit further study are identified and conclusions are drawn. The material is presented under the following headings:

1. Relational view of the data.
2. Security procedures.
3. User's approach to the system.
4. Instructional text.
5. Magnitude of the COBOL generating system.
6. The generated COBOL program.
7. Towards more effective computer usage.
8. Aspects for further study.
9. Concluding summary.

8.2 RELATIONAL VIEW OF THE DATA

The system described in Chapters 6 and 7 has the advantage of being able to present the user with a relational view of his data at the user interface. No knowledge or understanding of the physical organisation of the data is required of the user, he has only to visualize it in tabular form.

The COBOL generating system makes use of flat data files which already exist and were not specifically designed for use in a relational data base. Each file is considered to be a relation and each field within the file to be a domain. Several relations may be joined to provide the data base submodel required for the

solution of the user's problem (5.3). Only sequence key fields may appear in more than one relation. If more than one data file is used to solve a problem, the generating system ensures that the names of all non-key fields will be unique when they are listed prior to problem specification (6.4.2).

8.3 SECURITY PROCEDURES

User access to the data is controlled. The data in the data base is protected by means of relation names each with a set of multi-level passwords (6.3.1). Thus each user need only be aware of a submodel of the data base and different users may have different views of it depending on the relation passwords allocated to them by the data base administrator. The security system protects the casual user from being overwhelmed by a large volume of superfluous data and at the same time restricts access to sensitive data.

As the files used by the COBOL report program generating system are created and maintained by other systems, it is assumed that they ensure the integrity of the data and provide adequate 'back up' should a file become corrupted. The integrity of the catalogue of file descriptions is the responsibility of the data base administrator. At present the generating system relies on the standard file dumping procedures of the computer installation for the recovery of the catalogue and macro definition subfiles in the event of a failure. This approach is inadequate for an operational system, especially if its facilities are extended to permit the updating of data files. The design and implementation of additional features to maintain the integrity of the system and the data base should form part of any future extensions of

this work.

8.4 USER'S APPROACH TO THE SYSTEM

Before engaging in the problem specifying dialogue the user must have identified his problem and know what data is required to solve it. He should also have an outline idea of the format in which he wishes the report containing the answers to his problem to be presented.

A previous user of the system will already have been supplied with the relation names and passwords which define the bounds of his data base. A first time user will need to consult the data base administrator in order to find out these details.

Although the problem specifying dialogue attempts to be self-teaching there is a great deal for the first time user to assimilate. In order to demonstrate the potential of the COBOL report program generating system and to complement the instructional aspects of the dialoge, an introductory booklet should be available to each first time user. The booklet should be based on the material in Section 5.9 of this thesis, and should contain a description of the model problem, details of the data base and its temporary extensions, an outline of the required report format, a listing of the problem specifying dialogue and samples of report output produced by the generated COBOL program.

Another aspect of 'getting to know and use' the system is the accuracy with which errors in the user's responses are detected and the ease with which they can be corrected. As all the user's responses are validated a considerable portion of the macro-time statements in each problem specifying macro are devoted to validation processing. When an error is detected a meaningful error message is output and the user is prompted to enter an amended response. The 'help' facility has an important role to

play in this respect. In circumstances where the user's terminal does not produce 'hard copy' it may be advantageous to 'journal' all the conversation so that it can be available for study.

8.5 INSTRUCTIONAL TEXT

Whilst the text illustrated in Appendix IX demonstrates that it is feasible to devise instructional text which prompts the casual user to specify his request for a report, the efficacy of the instructional text requires further assessment.

In order to make a qualitative assessment of the instructional text, the dialogues with numbers of users, whose requests for a report cover a wide spectrum of applications, should be analysed. This underlines the need for an operational system as a basis for further research.

Users' comments:

The comments entered by users at the conclusion of the problem specifying dialogue would provide one source of assessment data.

Analysis of errors:

More revealing, perhaps, would be the user responses to dialogue prompts which, when validated, cause error messages to be output. These would serve to highlight the less effective stages of the instructional text. The dialogue stages where the user has to enter other than single character responses are expected to yield the most information, e.g. condition specification, editing, line formats and own code statements.

Calls for 'help':

Another possible source of material for assessing the

effectiveness of the instructional text is the HELP macro. This could be enhanced to include a facility for logging details of the dialogue stage from which the macro was called and the help option selected.

System familiarity:

As a user becomes more familiar with the instructional text it is likely that he will not wish to waste valuable time waiting for all of it to be output on his terminal each time he specifies a request for a report. This is especially true if the user is working at a teletype terminal, but it can still prove irritating with a faster peripheral.

Macro processor facilities for suppressing all or selected parts of the instructional text already exist in the form of the %QUIET and %TALK system commands and in the WRITEOFF and WRITEON macro-time statements (Appendix I). A description of how to use these system commands can readily be incorporated in the instructions to the user in Stage 1 of the problem specifying dialogue. The macros for the various problem specifying stages are easily amended to incorporate WRITEON macro-time statements. These are used to override the %QUIET system command and force the dialogue back into 'talk' mode so that requests for information and error messages appear on the user's terminal.

8.6 MAGNITUDE OF THE COBOL GENERATING SYSTEM

The macros which create and maintain the CATALOGUE subfile containing the data base file descriptions have been developed and their listings are available in the separate folder. Excluding comments, approximately 800 macro-time statements were required to code these macros.

Coding details for the macros of the first eight stages of

the problem specifying dialogue are also available in the separate folder, but the development of macros beyond STAGE3 is incomplete. Some 2100 macro-time statements, excluding comments, were used to code these macros. It is estimated that the coding needed to implement the macros for all stages of the problem specifying dialogue would extend to between 5000 and 5500 macro-time statements.

The macros which generate the complete COBOL program from the common data subfiles and the 'grown' macros would, it is estimated, require a further 900 to 1000 macro-time statements.

The experience gained while developing macros for the system showed that, although the macro processor language is very suitable for generating COBOL statements, it is at rather too low a level for response validation or for accessing the contents of fields within subfile records. For example, higher level language features similar to the Free format READ of certain FORTRAN dialects or the COBOL CLASS Condition test for identifying numeric and alphabetic strings would facilitate the coding of macros.

As described in Section 7.3 the COBOL report program generating system relies heavily on the PG/2 macro processor filing system for the storage of a large number of macro definitions, text and common data subfiles. This extensive use of disc storage tends to make the generating system 'peripheral limited' (7.29). If the macro processor language supported array type variables, the use of subscripts would enable the number of common data files to be reduced.

The COBOL generating system does, however, demonstrate that good COBOL code for solving the user's problem can be generated from the information entered by the user during a, albeit lengthy, computer dominated dialogue.

8.7 THE GENERATED COBOL PROGRAM

Although the improvements identified during the Filetab to COBOL translation study (3.7) were incorporated in the design of the generated COBOL report program, there is still some scope to make further improvements, in order to make it comparable with the best hand coded program (7.29).

It seems likely that with further work it would be possible to revise and amend the generation strategy to optimise the generated COBOL report program. The generation process could also be generalised to cope with other problems.

8.8 TOWARDS MORE EFFECTIVE COMPUTER USAGE

Assuming that all the implementation problems associated with the PG/2 macro processor (4.8) can be resolved, it is estimated that, using the COBOL report program generating system, a casual user would require a terminal session of between 3 and 4 hours to specify the model problem described in Section 5.9. The estimate is based on the length of the problem specifying dialogue, which is assumed to be conducted on a teletype capable of printing at 10 characters per second, with due allowance for 'thinking time'. With a faster terminal, the time required to output the instructional text would be significantly reduced, say by a factor of 3 or 4.

In order to assess the contribution that the COBOL generating system could make towards more effective computer usage, comparisons of the man hours required to produce a similar report using other software systems should be made. Ideally the comparisons should include the use of other report generators such as Filetab as well as the development of hand coded COBOL programs.

Investigations carried out by Chrysler [21] into program development times suggest that these depend on the experience of the programmer and certain program characteristics, particularly those associated with the number and complexity of the files used. These findings are corroborated by the estimating procedures currently in use by a Software house [22]. These estimating procedures take into account the difficulty of the problem, the estimated size of the COBOL Procedure division (excluding paragraph and section names) and the number of files used by the program. This information is used in a set of confidential formulae to predict the number of hours an average programmer would take to flowchart, code, test and document a program.

The model problem (5.9) uses three input files and one output file and was assessed to be of average difficulty. In order to take account of the potential improvements noted in Section 7.29, it was assumed that the hand coded Procedure division would be only 95% of the size of the generated one (Appendix X). This data used in the above mentioned formulae yielded a figure of 58 programmer hours, excluding documentation time, as the estimated development time for a COBOL program to solve the model problem.

Not only does the COBOL report generating system show considerable potential for a saving of man hours, which could be of the order of 93%, it allows the same task to be achieved by a person with much less technical skill and training. A skilled user with an up to date video terminal would be able to make even more effective use of the system, for he would be able to dispense with much of the instructional text and concentrate on the problem specifying dialogue. With effective response validation, routine testing and rewriting to remove 'oversights' would be virtually eliminated.

The use of the COBOL generating system would influence program maintenance. It would be possible to extend the system so that important parts of the dialogue are filed. Facilities could then be provided for the user to vary the dialogue as it was reloaded and then the amended program could be generated.

Another application of the COBOL generating system would be to adapt it so that it generated programs in the COBOL dialect used in a micro computer. Thus inexperienced users could generate their COBOL programs on the mainframe computer and transfer the source code to the micro computer for compilation and execution.

When a fully operational version of the COBOL report generating system has been developed, there is scope for gathering data to investigate savings in the use of computer resources. The terminal connect time and CPU or 'mill' time usage required to generate a COBOL report program can be compared with those required to develop a hand coded COBOL program to produce the same report. The production run time statistics for the generated and hand coded programs can also be compared.

8.9 ASPECTS FOR FURTHER STUDY

The aspects for further study fall under six main headings:

1. Those related to the PG/2 macro processor.

2. The extension of facilities offered during the report requesting stages.

3. The extension of the technique to other information processing problems.

4. The benefit to the skilled user.

5. Consideration of alternative host computers and languages.

6. Other applications.

8.9.1 PG/2 macro processor

In addition to the provision of the stack emptying facility and improving access to subfile records as discussed in Section 4.8, some other aspects of the PG/2 macro processor merit further study.

First there is a need to consider the provision of better diagnostic facilities during the development of macro definitions. At present errors in macros are indicated by the output of messages in the form 'ERROR NO. nn' (Appendix I Section 9). As there is no indication as to which statement the message refers, it is often difficult to identify, especially in large macro definitions.

If an error occurs during the execution of a macro it would also be advantageous for the user to be able to request the output of local, global and string variables. A trace-back facility would also help to determine how far the macro evaluation had proceeded.

The facility to 'grow' macro definitions is another aspect of the PG/2 macro processor which merits further study. Only relatively simple macros were 'grown' during the investigations into the generation of COBOL programs. There is, however, scope for examining the problems of 'growing' more complicated macro definitions, especially those which contain arguments, CHAIN statements or nested calls to other macros. If such a study established the feasibility of 'growing' macros containing CHAIN statements, there is potential for improving the efficiency of the the third phase of the system which generates the complete COBOL program. The loading of 'grown' macros with empty bodies could be greatly reduced.

As the PG/2 macro processor is machine dependent the use of

other languages for COBOL generation is briefly considered in Section 8.9.5.

8.9.2 Extension of facilities offered during the report requesting dialogue

In addition to the facilities already proposed but not yet implemented, e.g. the wide report page and the default formatting of report lines, the following paragraphs highlight some other possible extensions.

The 'help' facility currently offers only 4 options, but the structure of the HELP macro is such that other options can readily be added. Some of those which might merit inclusion are considered below:

1. Access to a glossary of technical terms, e.g. relation, domain, etc.

2. Access to the contents of the LABELTABLE subfile in order to be reminded of the label character assigned to a particular domain for the purposes of format specification.

3. Access to the DOMAININDEX subfile so that the user can be reminded of the size and type of data in a given domain or temporary item.

4. To provide a LIST facility whereby the user may (possibly selectively) inspect the CATALOGUE subfile definitions of all files and fields to which he has password access.

A facility to record the details of the user's complete problem specification could be provided. This would enable minor changes to be made at a later date without the need to repeat all the stages of the dialogue. If, as discussed later (8.9.3 and 8.9.4), the program generating system were extended and generalised for use by programmers, this facility would become more important. It would provide a means of program documentation

and a basis for program maintenance and future development.

Another aspect which merits development is the extension of the methods of file organisation and data types which can be processed by the generated COBOL program. At present there is provision for only sequentially organised data files whose records contain numeric and alphanumeric character fields with DISPLAY usage. Already the catalogue of file descriptions in the CATALOGUE subfile anticipates that direct acces and indexed sequential files will be included. The implementation of this and the inclusion of other data usages, e.g. COMPUTATIONAL, for the fields of input records would extend the usefulness of the COBOL generating system. There is also potential for some relaxation in the key matching criteria imposed when the user wishes to use more than one data file (relation) to solve his problem (6.4.2). These enhancements would extend the data base available to the user.

At present the problem specifying dialogue does not warn the user when a problem domain or temporary item (6.6) is neither referenced by own code statements nor included in the report. Also there is no provision for detecting 'size errors' which result from from the totalling facility or arithmetic own code statements. The provision of additional validation in respect of these would make a small contribution towards ensuring that a semantically correct COBOL program was generated. An operational system which can be used, and modified in the light of experience, is needed to see how far one can go towards obtaining semantically correct programs. In the end only the user can say whether the COBOL program did what he intended!

There may be times when the report requested by the user contains only items from non-key fields. As not all fields can be treated as domains (6.3.2) the report may contain duplicate

detail lines. The option for duplicates to be omitted from the report could be offered in Stage 10 of the problem specifying dialogue. The provision of this facility would in certain circumstances require the generated program to contain SORT statements and include additional file descriptions for sorting work files.

There is too the possibility of adding new powerful macros to speed up the request processing. These macros would be defined either by the data base administrator or by a skilled user.

8.9.3 The extension of the technique to other information processing problems

Once the efficacy of the self-tutorial approach has been established, the range of information processing problems which can be solved by the generation of a COBOL program can be extended to include, for example, file updating. Such an extension would require changes to the problem specifying dialogue and the provision of more own code facilities. The structure of the generated COBOL program would have to be reorganised to process additional input and output files.

8.9.4 The benefit to the skilled user

Although designed primarily for the casual user, the man-hour estimates quoted in Section 8.8 show that the COBOL generating system is potentially of great benefit to the skilled user.

With a skilled user a shorter problem specification dialogue would be needed as the instructional text could be dispensed with. Dialogue changes could also be made to take advantage of the programmer's ability to use a more sophisticated terminal device, e.g. light pen, data pad, etc. The availablity of such devices

would prove particularly beneficial for the design of report page layouts.

8.9.5 Consideration of alternative host computers and languages

The PG/2 macro processor is written in PLAN, the assembly language of the ICL 1900 computer series. The life of this range of computers is limited as it is being superceded by the ICL 2900 series of computers. This situation raises a number of points which merit further study.

Should effort be devoted to converting and restructuring the PG/2 macro processor for use on the ICL 2900 series? This would facilitate further development and evaluation of the COBOL generating macros described in Chapter 7 together with the improvements and additional facilities outlined in this chapter. Such an approach could be considered only if it was worthwhile running the PG/2 macro processor using the 1900-emulation package. This would be a short term solution because of the defects in the macro processor software which cannot be easily or cheaply remedied.

Alternatively, would it be beneficial to implement the self-teaching COBOL generating system in a more universal host language? This would certainly make the system more portable for implementation on other makes of computer. In general the high level computer languages have facilities for program overlay, direct and indexed sequential file access, array storage and good error diagnostic facilities. Facilities for the manipulation of variable length strings, data validation and statement generation are not so generally available. Often, however, these facilities can be provided by means of subroutines which may have to be coded in assembly language.

Consideration needs to be given to ways of adding to the

high level language facilities and discovering how far they could be coded directly in the high level language. As there are currently moves to enhance the COBOL language facilities, this is one of the obvious high level languages to consider for the development of a COBOL generating system. A working paper prepared by the British Computer Society COBOL Specialist Group [23] contains a justification and description of proposed language enhancement features for COBOL which have already been proved by a pilot implementation. Although in June 1980 the CODASYL COBOL Committee rejected these proposals by a small majority, work continues on refining and improving them.

The experience gained during the practical work of this project provides the basis for an initial attempt at defining the range of facilities required for the generation of COBOL programs (Appendix VI).

8.9.6 Other applications

The number of micro-computers will soon greatly exceed the number of programmers available, so there is scope for developing ways of making them easier to use by non-specialists. As there is a growing tendancy for a dialect of COBOL to be offered for use on such computers, the provision of facilities for generating COBOL programs would contribute to their effective use. As mentioned in Section 8.8, the source code for programs in a micro-computer COBOL dialect could be generated on a main frame computer and transferred to the small computer for compilation and execution. There is also scope for investigating to what extent program generation facilities could be provided using the micro-computer itself.

8.10 CONCLUDING SUMMARY

The project set out to see if, by the generation of COBOL programs, access to the computer by casual users could be made easier. What has been done and learned as the result of this project can be summarises as follows:

1. A dialogue can be created which can be used to generate COBOL programs.

2. Validating the dialogue responses and generating COBOL is a major undertaking leading to a system comparable in size and complexity to that of a compiler.

3. The PG/2 macro processor is not an ideal tool but it has helped to discover the characteristics of an appropriate tool.

4. Program generation appears efficient but may be of even more use to the professional programmer than to the casual user.

5. An operational system is needed to validate the potential of this approach.

6. The project can be easily and naturally extended in many ways, thus providing a continuing opportunity to contribute towards easier and more effective computer usage.

APPENDIX I

PG/1 MACRO PROCESSOR

APPENDIX I

PG/1 MACRO PROCESSOR

The PG/1 macro processor may also be considered as a general purpose string processor because its macro-time facilities allow the extraction, identification, manipulation and concatenation of string variables.

The material provided in this appendix has been extracted from a report of a earlier investigation [5]. It gives a description of the PG/1 macro processor used for the preliminary investigation into the feasibility of generating COBOL programs. The material is subdivided into the following sections:

1. Macro processor structure
2. Statement layout
3. Macro definition format
4. Macro calls
5. Expansion-time statements
6. System macros
7. Macro-time statements
8. Reserved global variables
9. Error messages

1. MACRO PROCESSOR STRUCTURE

The PG/1 macro processor has two buffers each capable of storing up to 72 characters, one buffer for input and the other for output. There are also storage areas used for label, symbol and pointer tables and stacks available for macro expansion statements, names or definitions and saved blocks of output text.

A disc-based filing system is available in the form of a collection of subfiles each of which may be used to contain macro definitions, partially developed macros or any other character data. In addition to the macro processor PG/1, two other programs are used to maintain the disc filing system. The filing system is initialised using the first of these programs and, once initialised, may be maintained by the second program. This latter program enables the user to allocate space for the creation of new subfiles and also has facilities for the input and output of character data, and for editing copying and deleting subfiles.

2. STATEMENT LAYOUT

The format of source input to the macro processor follows standard FORTRAN convention with labels in positions 1 to 5 and statements in positions 7 to 72. (The use of column 6 as a continuation record was suspended as mentioned in Section 2.2.4). The FORTRAN convention arises from the fact that initially the PG/1 system was used to generate FORTRAN programs. Where labels are generated by the system these are FORTRAN type integer labels, but apart from these considerations the PG/1 system is not biased towards any particular source language.

The original MP/1 system [6] was designed to be used both as a macro processor and a pre-processor and consequently the format of macro names was made less restrictive than is the case for most macro systems.

3. MACRO DEFINITION FORMAT

The macro definition specifies both the macro name and the associated replacement body or expansion string. A definition is initiated by the pseudo macro %DEF. The pseudo macros and all the system macros start in position 1 of an input record. The macro name follows and is taken to terminate at the end of the statement record. The subsequent statements up to the pseudo macro %END are taken to constitute the macro body. Definitions are written using the ICL 64 character set although some special characters are excluded.

The macro name is a character string intersperced with formal parameters where desired. Two or more formal parameters must not appear consecutively in a name as the intervening sub-strings between parameters of the name are used as argument terminators when matching macro calls. However, a single formal parameter may be defined to represent a variable number of actual parameters as described below. It is also useful, especially in the case of variable parameter lists, to be able to specify that the parameter, or each parameter of a list, should be balanced with respect of left and right parentheses. This feature is provided together with a feature equivalent to the keyword parameter of the System/360 Macro Language. In the latter, a formal parameter may have its value set in the definition and if the corresponding actual parameter in the call is omitted then the value is used as if it were the actual parameter, otherwise the preset value is overwritten by the value obtained by matching. Using a notation based on Bakus Normal Form [8] the name definition takes the general form defined below:

⟨macro name⟩ ::= $\int_1^*\{$⟨arg⟩⟨delimiter⟩$\}$ |
⟨delimiter⟩⟨macro name⟩ |
⟨macro name⟩⟨arg⟩ | ⟨delimiter⟩ |
⟨arg⟩

⟨arg⟩ ::= @⟨inset⟩@

⟨inset⟩ ::= ⟨null⟩ | (⟨null⟩) |
⟨sep⟩ | (⟨sep⟩) |
⟨inset⟩ =⟨preset list⟩

⟨null⟩ ::=

⟨sep⟩ ::= $\int_1^3\{$⟨char⟩$\}$

⟨preset list⟩ ::= '⟨preset argument⟩' |
'⟨preset argument⟩',
⟨preset list⟩

⟨preset argument⟩ ::= $\int_1^*\{$⟨char⟩$\}$

⟨delimiter⟩ ::= $\int_1^*\{$⟨char⟩$\}$

Where ⟨char⟩ is a member of the character set defined above.

From these definitions it follows that the formal parameter ⟨arg⟩ is a sequence of one or more characters enclosed by @ symbols. When this takes the form @@ then the parameter is a single element which need not be balanced. When the formal parameter is of the form @⟨sep⟩@ then this denotes that the macro call will contain a list of one or more elements corresponding to this one parameter. The one, two or three characters denoted by ⟨sep⟩ will serve to separate the individual elements of the actual parameter list. In either of these cases if a left parenthesis immediately succeeds the first @ symbol and a right parenthesis immediately precedes the second @ symbol then a check is made to ensure that the actual parameter and each element of the actual parameter, if appropriate, is balanced with respect to the symbols (and). Also a parameter or parameter list may be preset as indicated above, the preset value being a list of one or more elements enclosed in quotes

and separated by commas.

The expansion string consists of optionally labelled statements which may be source language, macro calls or expansion-time statements. Macro calls internal to a definition are enclosed in square brackets and may appear either within a source language statement, another macro call or as a separate statement. Expansion-time statements are described below.

When a macro call is expanded labels inside the definition are replaced by unique five digit labels. Labels outside columns 1-5 of source language statements must be prefixed by a # character. Formal parameters may be used in the definition to show points where the corresponding actual parameters of the call are to be inserted. These parameters are similar to formal parameters in the name and take the following form:

⟨exarg⟩::: @⟨int⟩⟨inset'⟩@

⟨inset'⟩::= :⟨int⟩ | :⟨expansion variable⟩ | ⟨sep'⟩
⟨null⟩

Where the first ⟨int⟩ is an integer establishing a correspondence between the formal parameter of the expansion string and the formal parameter of the name, 1 referring to the first (left most) parameter of the name, 2 to the second and so on. Where the formal parameter is a simple one then this integer is followed by a second @. In the case where the formal parameter refers to a parameter list then the integer may be followed by a colon followed by either an integer or an expansion-time variable containing an integer. This second integer quantity will then specify the particular element of the list to be output, e.g.

@2:3@

would refer to the third element of the second parameter. Alternatively the parameter list can be output as a list in which

case it takes the form

@⟨int⟩⟨sep'⟩@

where ⟨sep'⟩ is the character string to be used to separate the output elements. This latter string may be of any length but should not commence with either a colon or an integer.

Two examples of a macro definition format are illustrated in Section 2.2.5. The first example shows a simple macro definition without arguments while the second example shows a macro which requires one argument.

4. MACRO CALLS

A macro call will be recognised as such by a special warning character in the first position. This will be a % character unless otherwise specified by the programmer as shown below. The call may be labelled. The macro call string will consist of the delimiters of the macro name to which it refers written in the order in which they appear in the definition of the macro name. Optionally parameters may be written between these delimiters. The parameters may be simple character strings or they may contain macro calls or literals. Such nested calls are parenthesised by square brackets and nesting to an arbitrary depth is permitted.

When a macro call has been successfully matched by the system against a defined macro name then the evaluation of the associated expansion string takes place. If the macro call was labelled then this label is inserted unchanged before the first source language statement of the expansion string. In the case where this statement is itself labelled a CONTINUE statement is generated with the macro call label. Evaluation then continues with the insertion of actual parameters in place of the formal parameters. Where an actual parameter has been omitted then the preset value, if it exists, is inserted otherwise the statement in

which that parameter appears is omitted. Evaluation continues either until the end of the expansion string is reached or until processing is halted by an expansion-time statement. When the original macro call has been completely evaluated processing continues at the first internal macro call, if it exists, and continues until all internal calls have been evaluated. When the macro call has been fully evaluated the generated string is transferred to the output stack.

Macro calls are matched in sequence against defined names starting with the most recently defined macro name and thus it is necessary in most applications to carefully order macro definitions.

5. EXPANSION-TIME STATEMENTS

Expansion time statements may be used to generate object code which is dependent on the parameters of the macro call. Expansion variables may be used as indexes, as criteria for conditional statements or as generators of internal symbol strings. They take the form

$$\text{expansion variable} ::= \#\,L\int_1^4\{\langle \text{char}'\rangle\} \mid \#\,G\int_1^4\{\langle \text{char}'\rangle\}$$

where ⟨char'⟩ is an alphameric character. Expansion variables may be local to a particular macro definition or they may be global, the two cases being distinguished by the first letter being L or G respectively. Variables may be assigned either integer values or string values of up to 8 characters. Expansion variables may appear in normal source language statements in the definition in which case during evaluation they are replaced by the character representation of their value at that time.

Expansion time statements are introduced by a % character in postion 1 of the statement and may have FORTRAN type labels for reference by other expansion time statements. The assignment and control statements take the form below:

$$\begin{aligned}
\langle\text{assignment}\rangle ::= {} & \langle\text{expansion variable}\rangle \\
= {} & \langle\text{expr}\rangle \\
\langle\text{expr}\rangle ::= {} & \langle\text{integer expr}\rangle \\
& \langle\text{string expr}\rangle \\
\langle\text{integer expr}\rangle ::= {} & \langle\text{int}\rangle \mid \langle\text{int}\rangle\langle\text{op}\rangle\langle\text{expr}\rangle \\
\langle\text{string expr}\rangle ::= {} & '\int_0^8\{\langle\text{char}\rangle\}' \mid \\
& \langle\text{string variable}\rangle \mid \\
& \langle\text{exarg}\rangle
\end{aligned}$$

where ⟨int⟩ is either a literal integer or an expansion variable holding an integer value and ⟨string variable⟩ is an expansion-

time variable holding a string variable. Where the <string expr> is a parameter reference, <exarg> , then if the parameter is greater than 8 characters in length the left hand variable will be set equal to the first 8 characters.

<op>::= +|-

Expressions may include simple arithemtic operations (addition and subtraction) between integers and variables holding integers.

<control statement>::= GOTO<label>|EXIT|
IF<rel>,GOTO<label>|
IF<rel>,EXIT|
CONTINUE

<rel>::= <IR>.<IOPR>.<IR>|
<SR>.<SOPR>.<SR>

<IR>::= <int>

<IOPR>::= EQ|NE|LE|LT|GE|GT

these six predicates being equal, not equal, less than or equal, less than, greater than or equal and greater than.

<SR>::= <string expr>

<SOPR>::= EQ|NE|IN|AT

The operation IN and AT in this case test if the first string is a substring of the second and if the first string is the first substring of the second, respectively.

The GOTO statement causes an unconditional transfer of control to the labelled expansion statement. EXIT causes evaluation of the current expansion string to stop and has the same effect as %END. The IF statement causes transfer of control if the specified relation is true and the CONTINUE has no effect, being used only as a label reference for other assembly time statements.

The statement

CALLARGS(<expansion variable>,<formal parameter>)

where

<formal parameter>::=@<int>@

sets the specified expansion variable to the number of elements contained by the associated actual parameter at the time at which it is called. If the parameter has been omitted the variable is set to zero.

6. SYSTEM MACROS

The system macros are used as data control operations and there are fourteen system macros in all.

6.1 %MACRO

The first record input to the PG/1 system must be of the form

%MACRO.

Optionally up to three characters may be inserted before the full stop. The first of these defines the macro warning character, the second the formal parameter marker and the third the expansion label marker.

Thus for example

%MACRO$*.

would cause the % warning character and the @ symbol to be replaced by $ and * respectively. In this case the label marker # would remain unchanged. This macro outputs the date and time together with a list of the three warning characters whether or not these have been redefined. All data following this record is listed but otherwise ignored until the %BEGIN statement is encountered.

6.2 %BEGIN

This statement causes all subsequent records to be treated as input to the macro processor. Statements which are part of neither macro definitions nor calls will not be altered in any way. The entire system is initialised by this statement. (See Section 2.2.5 for an example).

6.3 %END

This statement causes the output stack to be listed. (See Section 2.2.5 for an example).

6.4 %FINISH

The input to the macro processor is terminated by this statement. (See Section 2.2.5 for an example).

6.5 %FILE

The form of this command is:

%FILE,p,<subfile name>%

It causes all the records following this command until an eight '%' character record is encountered to be stored in the subfile referenced. p=0 starts storing from the top of the subfile; p=1 starts storing from the end of the current contents of the subfile.

```
%FILE,0,INPUTDATA%
record 1
record 2
record 3
record 4
%%%%%%%%
```

causes four records to be stored at the top of subfile INPUTDATA.

6.6 %LIST

This command will cause the names of all the macro definitions currently held in the store to be listed.

6.7 %LOAD

The form of this command is:

%LOAD,<subfile name>,.....,<subfile name> %

This command loads into the PG/1 stacks the current contents of the subfiles referenced. Up to four subfile names may be given.

A subfile may hold one or more macro definitions, partly developed definitions or any other data. (See Section 2.2.5 for an example).

6.8 %PRINT

The current contents of the PG/1 output stack will be printed out by this macro. (See Section 2.2.5 for an example).

6.9 %QUIET

This command sets the translator-user dialogue into silent mode i.e. supress written messages.

6.10 %RESTART

The user may delete the translator-user dialogue carried out so far, re-initialize the expansion stack and re-set the system to accept a fresh macro call by means of this command.

6.11 %SAVE

The form of this command is:

%SAVE,p,⟨subfile name⟩%

The command causes the current contents of the PG/1 output stack to be saved in the referenced subfile. Parameter p plays the same role as described with %FILE above. (See Section 2.2.5 for an example).

6.12 %START

The purpose of this macro is to load into the PG/1 system the contents of the subfile "EXPLANATIONS". This subfile holds macro definitions which, when called, provide explanatory dialogue on the PG/1 system and its facilities.

6.13 %TALK

This macro will set the translator-user dialogue into its normal mode, i.e. nullify the %QUIET command and re-issue written messages.

6.14 %DEF

The function of this macro is described in Section 3 of this appendix.

7. MACRO-TIME STATEMENTS

These statements are introduced by a '%' character in the first position of the statement and may have FORTRAN type labels for reference by other macro-time statements. These statements are listed below alphabetically.

7.1 CALLARGS

Determine the number of elements contained in a referenced call parameter. (Details in Section 5 of this appendix).

7.2 CALLCONV

Convert an integer held in character form to its binary equivalent.

% CALLCONV (⟨m-t. vble⟩,⟨m-t. vble⟩)

where ⟨m-t. vble⟩ may be either a local or global macro-time variable and they may be combined at will-

e.g. % CALLCONV(#LVAL,#GVAL)

7.3 CALLCOPY

Copy the character string, or the contents of a referenced macro-time variable, into the macro-time output buffer starting from the specified character position. If the latter is not explicity given then use the value held in the reserved global variable OUP.

% CALLCOPY(n,⟨message⟩)

where ⟨message⟩ ::=⟨text⟩|⟨macro-time variable⟩

⟨text⟩ ::= any combination of the ICL 64 character set and n = 0, 1, 2, ..., 72.

The ⟨message⟩ must not exceed 20 characters in length. This is a compromise figure, being typical of the maximum length of a system user message in scientific applications.

The effect of this statement is to copy the message into the macro-time output buffer, starting at the nth character position, and replacing each % character in the message by a space character.

e.g. % CALLCOPY(1,THIS%IS%A%MESSAGE!)

7.4 CALLFSTR

Copy a fixed-length string variable from the input buffer into a referenced macro-time variable. If the values for the character position in the input buffer and the length of the string to be copied are not explicity specified, then use the values held in the reserved global variables INP and OUP respectively.

% CALLFSTR(<m-t. vble>,i,j)

which stands for CALL Fixed STRing, and where

<m-t. vble> is a local or global macro-time variable

i is an integer value 0, 1, 2, ..., 71

j is an integer value 0, 1, 2, ..., 8

and $1 < (i+j) < 72$

The effect of this statement is to assign to the specified macro-time variable j characters, starting from the ith character postion in the input buffer.

e.g. % CALLFSTR(#LVAL,1,1)

7.5 CALLVSTR

Copy a variable-length string into a referenced macro-time variable starting from a given character position until either a specified marker is encountered or 8 characters have been copied. If the value of the character position and the marker are not explicitly given, then use the values held in the reserved variables INP and MAS respectively.

% CALLVSTR(<m-t. vble>,i,<marker>)

which stands for CALL Variable STRing, and where

<m-t. vble> is a local or global macro-time variable

i is an integer value 0, 1, 2, ..., 71

<marker> is any character of the ICL 64 character set.

The effect of this statement is to assign to the specified macro-time variable all characters up to but excluding the <marker> character when it is encountered.

e.g. % CALLVSTR(#LV3,1,5)

7.6 CONTINUE

This statement has no effect. It is used by macro-time statements as a label reference for other records in the macro body. (See also Appendix I Section 5.)

7.7 COPY

Copy the corresponding SAVE block. This statement is executed at output only.

% COPY n

where n is an integer.

This statement is used in association with the SAVE/ENDSAVE statements and causes the contents of SAVE block n to be copied into the output stack.

7.8 DEPOSIT

Copy, starting at the first available 'unfilled' character position of String variable Sn, the contents of a referenced macro-time variable, the contents of another String variable, ordinary text or a combination of any of these. String variable is filled from left to right.

% DEPOSITn <choice>%

where n = 0, 1, 2, ...

The effect of this statement is to copy all the information in, or referenced by, choice into (i) the string variable $n when n 1,2, ..., or into (ii) the output buffer when n=0. The statement must be terminated by a '$' character, the significance of which becomes clear as <choice> is defined.

<choice>::=<macro-time variable>|<string>|<string variable>|
<choice><macro-time variable>|<choice><string>|
<choice><string variable>

<string>::=$1* (any combination of the ICL 64 character set excluding $).

The only limitation is that the total number of characters DEPOSITed into the String Variable referenced must not exceed 72. As with CALLCOPY each % character in <string> is replaced by a space character.

7.9 ENDSAVE

Terminate the effect of the SAVE statement (see below).

7.10 EXIT

Stop the evaluation of the current expansion. This has the same effect as the system macro %END. (See Appendix I Section 5 for details).

7.11 GOTO

Transfer control, unconditionally, to the labelled macro-time statement. Label may be either explicitly specified or held in a referenced macro-time variable.

e.g. % GOTO 123

% GOTO #GV3

7.12 IF

Transfer control if the relation specified is true. (See Appendix I Section 5 for details).

7.13 LABELOFF

Suspend processing positions 1-6 of all the following records; simply copy their contents unchanged.

7.14 LABELON

Nullify the function of an earlier LABELOFF statement.

7.15 NOTE

This statment has no effect. Processing simply continues at the next statement. This statement is used to document macro definitions.

7.16 OBEY

Transfer control, unconditionally, to a specified labelled statement, and set a second label into a RETURN word.

% OBEY <label 1> , <label 2>

where <label 1> is a label on the first statement of the routine. <label 2> is used in conjunction with a RETURN statement to have the effect of an unconditional jump statement.

7.17 READ

Read a record, from the teletype or the card reader, into the macro-time input buffer.

7.18 READ #Sn

Read the contents of the String Variable #Sn into the macro-time input buffer. #Sn is then empty.

7.19 RESET

Reset the referenced String variable ready for filling it up starting from its first character position.

% RESET #Sn

where n is the number of the String variable.

7.20 RETURN

Branch back to the statement labelled with the label ⟨label 2⟩ held in the corresponding OBEY statement.

7.21 SAVE

Suspend sending the following generated records into the expansion stack until an ENDSAVE statement is encountered. Instead, store these records in referenced SAVE-block at the end of the current expansion stack.

% SAVE n

where n is the number of the SAVE-block.

7.22 SQUASH

Squash all the spaces out of the current contents of the input buffer. Store the character count of the resultant contents of the input buffer in reserved global variable STC.

7.23 TEST function

Test the contents of a specified macro-time variable to conform with the function specified and set the global variable indicator TST.

% TEST⟨function⟩ (m-t. vble)

where ⟨function⟩ ::= DIGT (meaning single digit)

::= LETR (meaning single alphabet)

::= INTG (meaning integer value)

::= REAL (meaning real value)

The effect of any of these statements is to test that the value of the macro-time variable referenced conforms to the property as specified by ⟨function⟩. If the test fails reserved variable TST is set equal to 1, otherwise it remains zero.

e.g. % TESTDIGT(#LVAL)

7.24 WRITE

Output the current contents of the macro-time output buffer on to the terminal, or line printer.

7.25 WRITE #Sn

Store the current contents of the macro-time input buffer in the referenced String variable #Sn.

7.26 WRITEOFF

This statement sets the translator dialogue into silent mode, i.e. it suppresses written messages.

7.27 WRITEON

This statement will set the translator dialogue into its normal mode, i.e. it will nullify the effect of the WRITEOFF macro-time statement or the %QUIET system command and allow written messages to be issued.

8. RESERVED GLOBAL VARIABLES

The following variables are reserved within the system. Their uses and the statements which effect each are indicated. They are listed below in alphabetical order.

CAL - (stands for CALL) holds a count of the number of calls so far processed. Its value is unique to each macro call.

CCT - (stands for Character CounT) holds the number of characters found by the CALLVSTR statement before the ⟨marker⟩ specified for it is encountered.

$0 \leqslant CCT \leqslant 8$

DEF - (stands for DEFinition) holds the sequence number of the current macro definition. Its value is unique to each macro definition.

FLA - (stands for FLAg) set equal to 1 or 0 depending on whether the marker specified for the CALLVSTR statement has been encountered or not.

INP - (stands for INPut buffer) points at a character position within the macro-time input buffer. It is used by the CALLFSTR and CALLVSTR statements when these are not explicitly parametized. READ sets INP = 1.

$1 \leqslant INP \leqslant 72$

MAS - (stands for MASk) holds the ⟨marker⟩ to be used with the CALLVSTR statement when the latter is not explicitly parametized.

OUP - (stands for OUtPut) points at a character within the macro-time output buffer. It is used by the CALLCOPY and CALLFSTR statements when these are not explicitly parametized. WRITE sets OUP = 1.

$$1 \leq OUP \leq 72$$

SPC - (stands for SPaCes) holds 8 'space' characters and may be used with the IF statement.

STC - (stands for STring Count) holds a count of the number of characters of the current contents of the macro-time input buffer. READ sets STC = 0.

$$0 \leq STC \leq 72$$

TST - (stands for TeST) set equal to 1 or 0 depending on whether one of the TEST ⟨function⟩ statements returns a 'Yes' or 'No'.

9. ERROR MESSAGES

Errors are generated in the form:

ERROR NO n

where n is an integer defining the type of error which has been found. Definition errors will cause an error number to be output and the erroneous record discarded. Processing errors will cause expansion of the current macro definition to be terminated and thus no output will be generated from this macro. Only one error per one input record is flagged, but more than one error may be flagged in a definition.

1 - Initial %MACRO either omitted or incorrect

2 - Parameters in initial %MACRO in error

3 - Pointer table full

4 - Either name or definition stacks full

5 - Label table full

10 - Should not occur

11 - Macro call cannot be matched

12 - More than three separators are used as element separators in argument

20 - Unbalanced macro-calls in definition

21 - Argument reference number in the definition is incorrect

22 - Unbalanced nested calls

23 - Incorrect argument format in definition

24 - Element specification reference is outside the possible range

25 - Text variable used as a element reference

26 - Second @ character omitted in definition

30 - Attempt made to perform a numercial operation on a text variable

31 - Argument element in IF statement is outside the possible range

32 - Incompatible parameters in an IF statement

40 - Incorrect argument format in macro name

41 - Incorrect format of statement

42 - Label defined twice

43 - Incorrect variable format

44 - Symbol table full

45 - Statement does not exist

46 - String variables exhausted

47 - Character string too long (>72)

50 - String variable does not exist

51 - Surplus ENDSAVE statement

52 - SAVE-block referenced does not exist

60 - Incorrect label in OBEY statement

61 - Character position referenced within String variable or INBUFF beyond bounds

62 - Character transfer by CALLFSTR > 8

63 - Character transfer by CALLCOPY > 20

64 - OUTBUFF over-full (>72 characters)

65 - IF statement wrongly ended

70 - File referenced cannot be opened

71 - Error in SAVE or FILE modes specified

72 - Incorrect format of SAVE or FILE commands

73 - Subfile referenced cannot be opened

74 - Error in writing into subfile

75 - Incorrect format of LOAD command

76 - Incorrect format of PRINT command

APPENDIX II

FILETAB LANGUAGE FEATURES

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FILETAB LANGUAGE FEATURES

This appendix gives a brief summary of those Filetab language features implemented in this study and is based on information extracted from the NCC Filetab manual [7]. The material is subdivided into three sections:

1. Classification of data.
2. Field Designation, Control levels and Report Page width.
3. Directive and Parameter formats.

1. CLASSIFICATION OF DATA

Filetab classifies data fields into three types (CONTROL, TOTALLING and TRANSFER), and uses a single character to identify both the field and the field type (Appendix II Section 2). TRANSFER fields are those which are transferred direct from the input file to the printed report. A TOTALLING field is a numeric field for which it is desired to accumulate totals. CONTROL fields are used to control the accumulation of totals and/or the layout of the report. Control fields are the sequence key fields of the input file and use of them permits the printing of totals and new headings when a sequence break occurs in a non-minor key field. For example, in the following records sequenced on three key fields sequence breaks occur between the records marked with an arrow.

Major Key	Sub-major Key	Minor Key	Non-key data fields
0100	10	01	
0100	10	05	
0100	10	06	
→ 0100	20	02	
→ 0200	10	04	
0200	10	09	
→ 0200	30	07	
0200	30	08	

2. FIELD DESIGNATION, CONTROL LEVELS AND REPORT PAGE WIDTH

2.1 FIELD SPECIFYING CHARACTERS

These characters are used to name a field in a record and to specify the way in which a field is to be used. They fall into three groups - transfer, control and totalling. The *INL directive parameters are used to name each data field required to produce the report by associating it with a character from the appropriate group.

2.1.1 Control fields

Up to six control fields are permitted and are represented by the characters M N O P Q R. M denotes the lowest or minor control level, while R denotes the highest or major control level. Starting with M these characters must be used consecutively for as many levels as are rquired. Thus if only three control fields are required only M, N and O are used.

2.1.2 Control levels

In addition to the six control fields defined by the above character group, two further levels , L and F, are defined. L denotes list level control, the lowest level of control which may be thought of as a control field which changes for every record listed. F denotes final level control, the highest control level associated with a report, which operates when grand totals are printed at the end of the report.

2.1.3 Totalling fields

A maximum of ten totalling fields are allowed for the accumulation of decimal data and one of the characters 0 1 2 3 4 5 6 7 8 9 0 is used to indicate such a field.

2.1.4 Transfer fields

There may be as many as ten transfer fields and these are denoted by a character from the following set:

A B C D E G H I J K

2.2 REPORT PAGE WIDTH

Filetab reports may have an output line of up to 160 characters, the practical line length depending on the number of print positions on the line printer. The layout of the printed line is defined by parameter records where one character position is used to represent one print position. Since line printers have in excess of 80 print positions, up to two input records are required to describe a line of print.

An attempt by a COBOL program to print a line longer than the number of print positions available on the printer causes an unwanted diagnostic message. The line printer at the installation where the translation macros were developed had the popular 120 characters per line facility, so this was adopted as the maximum line width for the generated COBOL program.

The macro processor used as a basis for the COBOL generation feasibility exercise was designed for interactive terminal use and had an input buffer restricted to a maximum of 72 characters.

The combination of the above two factors made it necessary to restrict Filetab parameter records to 72 characters and to use 48 characters from a second parameter record for print positions 73 to 120.

3. DIRECTIVE AND PARAMETER FORMATS

3.1 *FILE DIRECTIVE

The *FILE directive is used to describe the nature of the input file to the system. The following format shows the options implemented in this study:

*FILE peripheral-code file-name

peripheral-code is a two character code being one of the following:

MT Magnetic tape

CR Card reader

file-name is the name of the input data file. The file-name is optional for card input but mandatory for magnetic tape.

N.B. If the file-name for magnetic tape is left blank the COBOL generator will assume that the file label contains blanks and will assign a default file name in the COBOL program. A maximum of 12 characters is permitted. The file-name may be terminated by a comma if it is less than 12 characters long.

3.2 *INL DIRECTIVE

This directive precedes the parameter records which associate a field specifying character with each of the required data fields. They define the way in which each field is to be processed in order to produce the desired report.

3.2.1 *INL parameter records

The entries in the parameter records are separated by commas and the next directive terminates the list. For the purposes of

this study it was assumed that no individual entry overflowed on to the next parameter record.

The entries take the form:

FSC FD

where FSC is the relevant field specifying character (Appendix II Section 2.1) and FD is the field definition which gives the start position and either length or end position of the field.

3.2.2 Field definitions

All fields in a record are referenced by their start position relative to the start of the record. The first character of the record is assigned position zero.

The Field definition may take either of the following forms:

S-E or S/L

where

S Start position of the field

E End position of the field

L Length of the field

The positions and lengths are defined in terms of character position references.

No attempt was made in this study to implement the Filetab Card Column notation and the above forms were applied to both magnetic tape and cards.

3.3 *TITLE DIRECTIVE

This directive is the first of three associated with the report format specification. It precedes the parameter records containing the text of a main heading to be printed on the first page of the report.

The format of this directive is:

*TITLE b,a

where b is the number of lines to be thrown before the print line(s) and a is the number of lines to be thrown after the print line(s).

b and a are unsigned integers and either b or a may be omitted in which case the default values 1 and 3 are respectively assigned to them.

3.3.1 *TITLE parameter records

The parameter records which follow the *TITLE directive may specify any number of lines called a 'print group'. Each 120 character print line requires two input records, the first contains 72 characters and the second the remaining 48 characters. Where an odd number of records is presented the last line is assumed to contain spaces beyond the first 72 print positions.

3.4 *HEAD DIRECTIVE

This directive precedes the parameter records containing the text to be printed as a heading at the head of every page or in association with a control break. The format of the directive is:

*HEAD control-level b,a,p

where

control-level indicates the heading group which will be printed at a break in the given control field and will be a single character from the set

L M N O P Q R

b,a are the number of lines to be thrown before and after the page heading

p is the maximum number of lines to be printed between occurences of the heading. In this study it is used at list level L.

b, a and p are unsigned integers.

Parameters may be omitted from right to left, intermediate parameters may not, however, be omitted. The default values assigned at missing control-level, b, a and p parameters are L, 1, 3 and 60 respectively.

3.4.1 *HEAD parameter records

The parameter records which follow the *HEAD directive are as for the *TITLE parameter records (Appendix II Section 3.3.1).

3.5 *OUT DIRECTIVE

This directive precedes parameter records giving, in picture format, an image of the print line(s) required for the main body of the report.

A parameter set must be specified for each print group to be printed at a control break, including List and Final levels.

The format of this directive is:

*OUT control-level b,a

where

control-level indicates the output group which will be printed at a break in the given control field and is a single character from the set

L M N O P Q R F

b,a are the number of lines to be thrown before and after the print group has been printed. b and a are unsigned integers.

Parameters may be omitted from right to left, intermediate parameters may not, however, be omitted. The default values

assigned to the missing parameters for control-level, b and a are L, 1 and 3 respectively.

3.5.1 *OUT parameter records

In common with other directives whose parameter records specify print line formats, two records per line are used (Appendix II Section 3.3.1). Text may be included in the print line by enclosing a literal within single quotation marks. The field specifying character is entered in the record positions in which it is desired that the field contents should be printed.

3.6 * COMMENT DIRECTIVE

A Filetab comment directive consists of an * followed by a space and the desired comment. Such directives may precede any other directive.

For the purposes of this study they serve two functions in the generated program:

1. The characters from positions 3 to 6 in the first comment record are used as the program-id. A default program-id is assigned if no comment directives are included in the input.

2. The text from all comment directives is formed into a NOTE paragraph at the beginning of the Procedure division of the COBOL program.

3.7 *GO DIRECTIVE

The *GO directive terminates the Filetab parameter set and indicates to the macro definition that the generation of the COBOL program statements may be completed.

APPENDIX III

MACRO PROCESSING OF FILETAB DIRECTIVES

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MACRO PROCESSING OF FILETAB DIRECTIVES

This appendix contains notes on the processing used to generate COBOL statements from the Filetab directives. Listings of the macro-time statements used are included in the separate folder (Items 4 to 10). Details of the special purpose string and global variables used to carry information from phase 1 to phase 3 of the system via the CONSTANTS macro are also included. The material is presented in the following order:

1. Special purpose string and global variables
2. * comment directive
3. *FILE directive
4. *INL directive
5. *TITLE directive
6. *HEAD directive
7. *OUT directive
8. *GO directive

1. SPECIAL PURPOSE STRING AND GLOBAL VARIABLES

The following variables are used in the CONSTANTS macro to pass information from phase 1 to phase 3 of the Filetab to COBOL generating system:

#S06 - Contains the File name used in the COBOL File definition.

#S07 - Contains the Label option clause for use in the COBOL File definition.

#GHEAD - Contains the control level characters of those levels for which headings are to be generated.

#GS01 - Switch used to indicate whether or not COBOL statements were generated for the NOTEPARA macro.

#GS03 - Switch used to indicate whether or not COBOL statements were generated for the TITLEPAR macro.

#GS12 - Switch used to indicate whether or not COBOL statements were generated for the FINALPAR macro.

#GS15 - Switch used to indicate whether or not COBOL statements were generated for the ADDPARA macro.

#GOUT - Contains the control level characters of those levels for which output is to be written.

#GV11, #GV12 - Contain the hardware name for the peripheral to be used for the input data file

#GV2 - Contains the four characters to be used as the COBOL program identification

#GVZ - Contains the maximum number of lines to appear on a report page.

2. * COMMENT DIRECTIVE

This is an optional directive but, if present in a Filetab job, its contents are formed into a COBOL NOTE statement. Since in COBOL any paragraph which begins with a NOTE is taken to consist entirely of commentary, a special NOTE-PARA paragraph is created at the beginning of the Procedure division for this purpose.

The first comment directive initiates the generation of the NOTE-PARA paragraph name and the NOTE statement. The characters in positions 3 to 6 of the * comment record are used to override the default value set for the program identification. A global variable #GS01 is set equal to 1 to denote the presence of a NOTE statement. Global variable #GV2 is used to store the program identification.

The comment statement may consist of up to 72 characters, which is longer than the space beyond the B margin of a COBOL statement. It is therefore arbitrarily broken into two COBOL lines, one of 60 characters and the other of 12. No attempt is made to interpret the contents of the comment records and this may lead to broken words and blank comment lines within the COBOL program.

Use is made of the routines which generate the system macro statements for filing the generated COBOL statements in the required subfile, which in this case is called NOTEPARA.

When the Filetab comment record has been processed and the appropriate statements generated, control is passed to the statement which reads in the next Filetab directive, i.e. the macro-time statement with 1 as its label.

The listing of macro-time statements for processing the * comment directive appears as item 4 in the separate folder.

3. *FILE DIRECTIVE

The *FILE directive contains details of the peripheral-code and file-name. The file-name is optional for cards but mandatory for magnetic tape, although in this case blanks are permitted. The peripheral-code is a two-character code in positions 7 and 8 of the *FILE record and the file-name, if present, occupies positions 10 to 21. A comma may be used to terminate the file-name if it is less than 12 characters long.

The generator uses the Filetab file-name, if present, as both the file-name and file label identification in the File description statements in the File section of the COBOL program's Data division. If the Filetab file-name is omitted, the generator assigns DEFAULT-NAME as the file-name for use in the COBOL program. When the Filetab file-name is omitted and the peripheral-code is for card input, the COBOL program will specify that Label records are omitted. On the other hand, if the file-name is omitted and the Filetab peripheral-code is for magnetic tape, the COBOL program will specify that Label records are standard but that the File label identification contains blanks.

File details are also required in the Environment division, Input-Output section, File-Control paragraph and the Procedure division paragraphs which contain the OPEN, READ and CLOSE verbs, so special purpose global and string variables are used to store the information derived from the *FILE directive.

While Filetab uses 'CR' and 'MT' to indicate the peripheral codes, the corresponding COBOL hardware names used in the ASSIGN clause of the File-Control paragraph are 'CARD-READER' and 'TAPES'. Since a macro-time variable can hold a maximum of 8 characters, two Global variables, #GV11 and #GV12, are used to store the hardware names. The way in which the hardware-name characters are assigned to the Global variables is shown below.

Filetab Peripheral-code	Contents of macro processor Global variables	
	#GV11	#GV12
CR	CARD-REA	DER
MT	TAPE	S

An invalid peripheral-code will cause the COBOL generating macro to print an error message.

String variable #S06 is used by the generating macro to hold the file-name for use in the Environment, Data and Procedure divisions of the generated program. The Label record clause for use in the File definition of the generated program is deposited in String variable #S07.

After the data from the *FILE directive has been extracted and interpreted, the macro generates the macro-time statements which save the contents of #S06 and #S07. These generated macro-time statements are 'grown' into the macro definition CONSTANTS, which is executed in the third phase of the system in order to restore these same values to the String variables #S06 and #S07.

When the *FILE directive has been processed and the constants set up, control is transferred to the statement which reads the next Filetab directive (See Figure 3.6).

The listing of macro-time statements for processing the *FILE directive appears as item 5 in the separate folder.

4. *INL DIRECTIVE

To assist with the generation of the REDEFINES statements used for each new record description, a field count variable #GFCT is maintained. This is initially set equal to zero.

The parameter records are read and processed one at a time until a new Filetab record, which begins with the * character, is detected. After each read operation the reserved global variable #GINP, used for pointing at a character in the macro processor input buffer, is set equal to zero.

Each field description is terminated by a comma or the end of the parameter record and it is assumed that no field specification continues on to another parameter record. The whole parameter record is squashed to remove unwanted spaces and the number of useful characters is automatically set in reserved variable #GSTC. A copy of the #GSTC value is stored in local variable #LSTC, because subsequent READ operations, which occur during the manipulation of some strings of numeric data, cause the value of #GSTC to be set equal to zero.

Each field description is processed character by character in order to extract the four constituent parts. Global variable #GV4 is used to hold the field specifying character, #GV5 is used to hold the start position of the field and #GV7 is used to hold the end position or length of the field. A '-' character stored in #GV6 denotes that end position is being specified, while a '/' character is used to denote that the length has been specified.

The CALLVSTR macro-time facility for extracting variable length character strings depends on the recognition of a specific terminator character. Since the terminator for the start position and length or end position strings has two alternatives, this facility cannot be used. This problem suggests that the development of an alternative form of the CALLVSTR function could

be considered, in which the string extraction is terminated when a match with any one of a list of characters is encountered. To circumvent the problem, the data is extracted character by character and stored in string variable #S01 until a non-digit character is detected. These strings are then transferred to the global variables #GV5 and #GV7 using the macro processor input buffer. Another string variable #S09 is used as temporary storage for the complete Filetab parameter record. Before arithmetic operations can be carried out on the numeric data in #GV5 and #GV7, they have to be converted from characters to binary using the CALLCONV macro-time statement.

The start and end position option, denoted by a '-' character in #GV6, shows that the values in #GV5 and #GV7 refer to card columns which have 1 as the origin. In contrast, the start and length option, denoted by a '/' character in #GV6, refers to records on other media where 0 is used as the origin. When the former option is used in the Filetab parameter record, the values in #GV5 and #GV7 are recomputed to reflect the 0 origin and the field length.

The File section COBOL statements for defining the input record (Section 3.5 of main text) were specifically designed to have a group structure so that the REDEFINES facility could be used at the 02 level. In the case of the first field on the Filetab parameter record, this takes the form

```
02  FILLER-1 REDEFINES IN-REC.
```

Subsequent fields make use of the field counter #GFCT to generate statements of the type

```
02  FILLER-n REDEFINES FILLER-m.
```

where m = n - 1 and n is the current value in #GFCT.

The level 03 statements for each record description are generated in three stages:

1. The initial FILLER field(s), if any.

2. The actual data field.

3. The final FILLER field(s), if any.

The value in #GV5 is used to generate the initial FILLER field(s), if any. If the required filler exceeds 120 characters, the maximum permitted in ICL 1900 COBOL, it is subdivided into multiples of 120 characters and a remainder. Since a divide operation is not available in the PG/1 macro processor facilities, this calculation is carried out by repeated subtraction.

The field specifying character in #GV4 and the field length in #GV7 are used to generate the actual data field level 03 statement. In the case of a totalling field, the numeric field specifying character has the letter A prefixed in order to make it a valid data name in COBOL, and the numeric picture character 9 is used with the value in #GV7 as the repetition count.

```
03  A#GV4 PICTURE 9(#GV7).
```

Transfer and control break fields use the alphabetic field specifying character from #GV4 with the alphanumeric picture character X. Again the value in #GV7 is used as the repetition count.

```
03  #GV4 PICTURE X(#GV7).
```

The length of the final filler field is calculated as

#LV1=2048-#GV5-#GV7

and the FILLER statement(s), if any, are generated in a similar way to the initial ones.

In the case of totalling fields, the field specifying character in #GV4 is used to generate the statements required to define the control totals in the Data division and to actually accumulate them in the Procedure division. Thus the statements

```
03  A#GV4 PICTURE 9(15) COMPUTATIONAL VALUE ZERO.
```

and

ADD A#GV4 IN INREC TO A#GV4 IN M-LEVEL.

are used to generate the COBOL statements for inclusion in the SAVETOTL and ADDPARA macros respectively.

The control break field, whose field specifying character is one of the set MNOPQR, makes use of the values in #GV4 and #GV7 to generate the COBOL statement for inclusion in the Data division group structure used to detect sequence changes.

02 #GV4 PICTURE X(#GV7).

The generated statement is destined for inclusion in the CTRLBRKE macro.

In all cases the necessary filing statements are also generated so that the macros to which they contribute can be 'grown'.

The macro-time statements for processing the *INL directive appear as item 6 in the separate folder.

5. *TITLE DIRECTIVE

The *TITLE directive and its associated parameter records specify the Report title to be printed at the top of the first page of output. This directive is optional. The *TITLE directive contains details of the line spacing required before and after the Report title. Default values for the line spacing are set if the second or both spacing parameters are omitted.

The directive is followed by parameter records which contain the text of the heading. Each 120 character line of text is entered on a pair of parameter records; the first contains the first 72 characters of the print line while the second contains 48 characters to be printed in positions 73 to 120 of the line. If the last 48 characters of the last line of the title are all to be blank, then the second record of the final pair may be omitted.

The information extracted from the *TITLE directive and

parameter records is required at two points within the generated COBOL program. In the Data division a data description for each line of the Report title is required, while the Procedure division must contain the WRITE statement(s) necessary to output the title line(s) with the required spacing. The COBOL statements are therefore directed to two macro definition subfiles, TITLES and TITLEPAR, by making use of the routine which generates the system macro filing statements.

The AFTER ADVANCING option of the WRITE verb is used to effect the required spacing before the first line of the Report title. Subsequent title lines are single spaced before printing. The final spacing after the Report title is achieved by writing a blank line with the desired spacing.

The processing of the *TITLE directive currently in the input buffer begins by setting global variable #GS03 equal to 1 to indicate the presence of this optional directive. Global variables #GV4 and #GV5 are used by this routine to contain the line spacing counts before and after printing. Initially these are set to have default values of 1 and 3 respectively.

The spacing options, if present, are extracted from the directive record and the title line counter, global variable #GV6, is initially set to 1. This latter variable is used to generate a level 01 group data description entry for each pair of parameter records, which takes the following form

```
01  TITLE-n.
```

where n is the value in #GV6. The value in #GV6 is incremented each time the first of a new pair of parameter records is detected.

The text from each pair of parameter records is extracted and used to generate three level 02 FILLER literals within the title line group description. The data from the first parameter record is used to generate two literals of 58 and 14 characters, while the

second parameter record's data is used to generate a 48 character literal to complete the record description. All the above statements are destined for the TITLES macro definition subfile.

The Procedure division statements generated by this routine are filed in the TITLEPAR macro definition subfile and are concerned with the actual writing out of the report title data. The contents of #GV4 are used in the generation of the WRITE statement for the output of the first title line. Subsequent title lines are single spaced but the contents of #GV6 are used to denote the actual record to be output. When all pairs of parameter records have been processed, the contents of #GV5 are used in the generation of statements to output the required number of blank lines after the title. In all cases statements to update the COBOL program LINE-COUNT data item are also generated.

An asterisk in position 1 of the first of a pair of parameter records is the signal that the *TITLE directive has come to an end and another directive has been detected. Control is then passed to the section of processing which identifies the new directive (See Figure 3.6). Listing Item 7 in the separate folder shows the macro-time statements for processing the *TITLE directive.

6. *HEAD DIRECTIVES

These directives and associated pairs of parameter records specify the text to be printed as a heading for each control level at the head of every page or in association with a control break. Each directive specifies the control level field to which the heading applies, the line spacing before and after the heading and in the case of control level L the maximum number of lines to be printed between occurrences of the heading.

As with the *TITLE directive, default values are set for the various options which take effect when they do not specifically

appear on the directive records. Global variables #GV4, #GV5, //GV6 and #GVZ are used to contain the control level character, the line spacing counts before and after printing and the maximum number of lines value respectively. The pairs of parameter records containing the heading text are processed in a similar way to those for the *TITLE directive.

A count of lines within each control level heading is maintained in global variable #GHCT and this, together with the control level character, is used to define the level 01 group entry in the COBOL program Data division for each heading line,

```
01  X-HEAD-n.
```

where X is the control level character from #GV4 and n is the line count value within that level from #GHCT. These group structures are generated for inclusion in the macro definition subfile called HEADINGS.

The Procedure division WRITE statement(s) to output the heading lines with the required spacing are generated in a similar way to those for the Report title. Global variables #GV5 and #GV6 are respectively used to effect the desired spacing before the first heading line and the blank line spacing after the heading. Global variable #GHCT denotes the number of the line within the current heading and this is used to specify the name of the record to be written out. As before, statements to update the COBOL program LINE-COUNT data item are generated. All the Procedure division statements associated with a control level heading are generated together with the necessary system filing statements for inclusion in the OTHERPAR macro definition.

An asterisk in position 1 of the first of a pair of parameter records signals the end of the current *HEAD directive and control passes to the macro-time statements which identify the new Filetab directive (See Figure 3.6 in main text).

The control level character from each *HEAD directive present in the Filetab job specification being processed is stored in the global variable #GHED, which is later used during the processing associated with the *GO directive.

A listing of the macro-time statements for processing the *HEAD directives appears as item 8 in the separate folder.

7. *OUT DIRECTIVES

The *OUT directives and their associated parameter records specify the contents and format for the detail and control total line(s) for each level of the report. Each directive specifies the control level to which the format set out in the parameter records applies, together with the line spacing before and after the output lines. The processing of the *OUT directive record is similar to that for the *HEAD and *TITLE directives in that default values are set for any options not specifically coded. Global variable #GOCT is used to maintain a count of lines within a print group and global variables #GV4, #GV5 and #GV6 are used to store the control level character and the line spacing counts before and after the print group.

The Data division output record descriptions are generated for inclusion in the OUTREC subfile and the level 01 entry takes the form

```
01  X-RECn.
```

where X is the control level character from #GV4 and n is the current line count value in #GOCT.

The WRITE statements which are generated for each level of the report from the information contained in the *OUT directive differ in three ways from those generated from the *TITLE and *HEAD directives. First, those generated for the detail level, L, are filed in the WRITEPAR macro definition subfile while those for

the other levels are filed in the OTHERPAR subfile. Secondly, the first WRITE statement of a group for any control level, excluding L, is preceded by a Procedure division paragraph name which takes the form

X-TOTALS.

where X is the control level character in #GV4. Finally, before the first WRITE statement for any print group a PERFORM statement is generated. This latter statement ensures that a new report page is started if the line count has reached the maximum permitted value as specified in the level L *HEAD directive, if present, otherwise the default value is used.

The pairs of parameter records which follow the *OUT directive are different from those of the two previously discussed directives. They specify not only text information but give details of the data fields (transfer, control or totalling) which are to appear in the printed line.

Each pair of parameter records which specify the format and contents of a report line is scanned character by character to establish the type and size of the fields contained therein. Any one of four different types of level 02 entry may have to be generated for inclusion in the COBOL group description for a record. Blank characters in the line parameter records cause the generation of a blank alphanumeric FILLER field with length equal to the number of consecutive blank characters, e.g.

02 FILLER X(n) VALUE SPACES.

where n is the count of consecutive blank characters which is accumulated in global variable #GV7. A filetab transfer or control character string in the parameter record(s) causes the generation of an alphanumeric data item of the following form:

02 Y PICTURE X(n).

where Y is the Filetab field specifying character stored in global

variable #GV9 and n is the length of the field. This latter is the number of consecutive occurrences of the field specifying character and this is again accumulated in #GV7. A Filetab totalling field specification causes the generation of a zero suppressed numeric report item which takes one of the following forms depending on the field width:

02 AY PICTURE Z(n-1)9.

02 AY PICTURE 9.

Y and n have the same meanings as above. Finally, a Filetab text literal which is enclosed in single quotation marks (') causes the generation of a COBOL alphanumeric FILLER field with a VALUE clause. The value assigned to the COBOL literal is the same as the Filetab literal together with one leading and one trailing blank character which replace the unused print positions occupied by the single quotation marks. String variable #S09 is used to store the Filetab literal. It should be noted incidentally that ICL 1900 COBOL uses the double quotation character (") to delimit a literal value. All 02 level descriptions are generated for inclusion in the OUTREC macro definition subfile.

In addition to the above record description entries, it is also necessary to generate MOVE statements to set up the required values in the record descriptions prior to the execution of the WRITE statements. In the case of the *OUT directive at control level L, these take the form

MOVE X IN INREC TO X IN L-RECn.

where X is the COBOL data name of the Filetab field and n is the record number within the level L output print group. These statements are generated for inclusion in the MOVEPARA macro definition subfile. At all other control levels of the *OUT directive, the MOVE statements take the form

MOVE CORRESPONDING X-LEVEL TO X-RECn.

where X is the control level character and n is the record number within the output print group for that level. These latter statements are generated for inclusion in the OTHERPAR macro and precede the WRITE statement for the record to which they refer.

An asterisk in position 1 of the first of a pair of parameter records signals the end of the current *OUT directive and control passes to the macro-time statements which identify the new Filetab directive (Figure 3.6 of the main text).

The control level character from each *OUT directive present in the Filetab job specification being processed is appended to the contents of global variable #GOUT, which is later used during the processing associated with the *GO directive.

A listing of the macro-time statements for processing *OUT directives appears as item 9 in the separate folder.

8. *GO DIRECTIVE

The *GO directive has no parameters and for the purposes of the COBOL program generating system merely serves to terminate a set of Filetab input data. However, once this directive is detected, there are seven tasks which may have to be carried out in order to generate statements needed to complete the macros being 'grown' by the system.

1. The first task is only carried out if a * comment directive was present in the Filetab input data. It consists of generating a full stop to terminate the NOTE statement in the NOTE-PARA paragraph.

2. The second task concerns the generation of the COBOL statements to ensure that the headings desired for each control level are output at the top of each new page. This task falls into two parts, first the generation of a PERFORM statement and secondly the generation of the paragraphs to be performed.

The writing out of the control level heading is executed by means of the PERFORM verb because the same processing is also required when a control sequence break is detected. The order in which the control levels are processed ranges from List level L through the major to the minor control level as contained in the global variable #GHED. Thus for control level M the statement

```
PERFORM M-HEAD THRU M-HEAD-EXIT.
```

would be generated for inclusion in the PAGEPARA macro. The following paragraphs would also be generated for inclusion in the OTHERPAR macro definition subfile.

```
M-HEAD.
    PERFORM PARA-LINE-CHECK THRU PARA-LINE-EXIT.
    IF PAGE-SWITCH NOT EQUAL TO ZERO GO TO M-HEAD-EXIT.
    PERFORM M-HEAD-WRITE.
M-HEAD-EXIT. EXIT.
```

3. The next task is concerned with the final processing in the COBOL program when the end of file on the input data file is detected. The final totals for all the control levels used in the job must be processed and written out in minor to major control level sequence. As before, this falls into two parts: first, the generation of the necessary PERFORM statements for inclusion in the FINALPAR macro definition subfile; and secondly, the generation of the paragraph which causes the current level control totals to be added to the next higher level totals. Because this same paragraph is also performed during the normal processing of a control break sequence, it contains a statement which resets the totals for the current control level to zero. For example, in a Filetab job using control levels M and N, the following statements are generated for control level M, the first statement is for inclusion in the FINALPAR macro definition subfile and the remaining statements are for the OTHERPAR subfile.

```
    PERFORM M-TOTALS.

M-ADD.
    ADD CORRESPONDING M-LEVEL TO N-LEVEL.
    SUBTRACT CORRESPONDING M-LEVEL FROM M-LEVEL.
```

4. The generation of the COBOL statements for detecting and processing a control sequence break forms the next task. These statements form a complete set of paragraphs, beginning with PARA-BREAK and ranging through to PARA-BREAK-EXIT, which are generated for inclusion in the BREAKPAR macro definition subfile. The IF statement which detects the sequence break is followed by statements which cause the control totals for all lower levels and for the current control level to be printed. These are then followed by statements which update the control break key fields and cause new headings for the current and lower control levels to be printed. If the previous example of a Filetab job with control levels M and N is used again, then the following paragraphs will be generated.

```
PARA-BREAK.
    IF N IN INREC EQUALS N IN CONTROL-BREAK
    GO TO M-BREAK.
    PERFORM M-TOTALS.
    PERFORM N-TOTALS.
    MOVE N IN INREC TO N IN CONTROL-BREAK.
    MOVE M IN INREC TO M IN CONTROL-BREAK.
    PERFORM N-HEAD THRU N-HEAD-EXIT.
    PERFORM M-HEAD THRU M-HEAD EXIT.
    GO TO PARA-BREAK-EXIT.
M-BREAK.
    IF M IN INREC EQUALS M IN CONTROL-BREAK
    GO TO PARA-BREAK-EXIT.
    PERFORM M-TOTALS.
    MOVE M IN INREC TO M IN CONTROL-BREAK.
    PERFORM M-HEAD THRU M-HEAD-EXIT.
PARA-BREAK-EXIT. EXIT.
```

5. The generation of the statements which enable the PART1 macro to be 'grown' forms the next task. This macro contains the Steering lines statements which specify the compiler options to be invoked for the COBOL program. The only variable data in this macro is the Identity which is contained in global variable #GV2.

6. As the penultimate task, the macro time statements for the CONSTANTS macro definition subfile are generated. This macro enables the contents of several global variables to be passed between the first and third phases of the system. The CONSTANTS macro is executed immediately prior to the GOPART2 macro which

synthesises the complete COBOL program. Thus the required contents of the global variables are restored and ready for use in the GOPART2 macro.

7. The final task is to generate the %END system macro statements which will be filed to complete each of the incomplete macro definitions that have been 'grown' by the generating system.

A listing of the macro time statements for carrying out the above tasks appears as item 10 in the separate folder.

APPENDIX IV

PG/2 MACRO PROCESSOR

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PG/2 MACRO PROCESSOR

The material in this appendix details the enhancements to the PG/1 macro processor for implementation in the PG/2 version and is subdivided into the following sections:

1. New or enhanced macro-time statements.
2. Additional reserved global variables.
3. New system macro.
4. Additional error messages.
5. Additional arithmetic operators.

The implementation of these facilities did not form part of the candidate's work.

1. NEW MACRO-TIME STATEMENTS

The following macro-time statements supplement or replace those listed in Section 7 of Appendix I.

1.1 CALL

Branch to the label specified and store in a private stack the return address, which is that of the next sequential instruction. The CALL statement is used to enter a subroutine which may itself contain CALL statements (Section 4.3 of main text).

% CALL label

where label is the label of the first executable macro-time statement of the subroutine. Return from the subroutine is effected by an EXIT macro-time statement (Appendix IV Section 1.10).

e.g. % CALL 9000

1.2 CALL DPOS

Concatenate strings in a macro-time variable (Section 4.6.4 of main text).

% CALL DPOS ⟨macro-time variable⟩, {⟨text⟩ | ⟨macro-time variable⟩}

The value of the right hand argument is concatenated with the value of the left hand argument and the result assigned as the new value in the left hand argument. Any variables referred to must have string values and the result is truncated to 8 characters in length.

e.g. % CALL DPOS (#LV1,#GV2)

If #LV1 and #GV2 initially contained 'HAPPY' and 'DAYS' respectively then #LV1 will contain 'HAPPYDAY'.

1.3 CALL LENV

Determine the length of a string or macro-time variable

containing a string value (Section 4.6.7 of main text).

% CALL LENV {⟨macro-time variable⟩|⟨string variable⟩}

Global variable #GSTC is set equal to the length of the string or macro-time variable.

e.g. % CALL LENV #LV2

If #LV2 contains 'VALUE' then global variable #GSTC is set equal to 5.

1.4 CALL SQUA

Remove spaces from string valued variable.

% CALL SQUA ⟨variable⟩

⟨variable⟩ ::= string variable|macro-time variable

All spaces are removed from the specified variable if it has a string value, otherwise an error message is generated and the macro processor halts. Global variable #GSTC is given an integer value corresponding to the number of non-space characters in the variable.

e.g. CALL SQUA #LV1

If #LV1 originally contained 'A B C' then it will contain 'ABC' after the execution of the statement and #GSTC will have the value 3.

1.5 CALL SWAP

Interchange characters in a macro-time variable (Section 4.6.5 of the main text).

% CALL SWAP ⟨macro-time variable⟩,⟨character⟩,⟨character⟩

Single or multiple occurrences of the left-hand character are replaced by single occurrences of the right-hand character. #GSTC is given an integer value equal to the number of characters in the result.

e.g. CALL SWAP #LV1,B,X

If #LV1 initially contained 'ABBE' then its contents will become 'AXE' after the execution of the statement and #GSTC will have the value 3.

1.6 CHAIN

Load a subfile and re-initialise.(Section 4.6 of the main text).

[CHAIN⟨control code⟩,⟨subfile name⟩]

The stacks and variables are re-initialised according to the option specified in the control code and the named subfile is loaded. The execution of this statement is deferred until the second pass of the macro in which it occurs. The CHAIN statement is always followed by one or more calls to the macros in the named subfile (Section 4.2 of main text).

Control code 0 = initialise stacks

1 = initialise global variables and stacks

2 = initialise string variables and stacks

4 = initialise global and string variables and stacks

e.g. [CHAINO,FILE1]
[M2]

Initialise the stacks, load the macros in the FILE1 subfile and call the M2 macro.

1.7 DATE

Obtain the current date from the operating system executive (Section 4.7.1 of main text).

% DATE

Global variable #GCDT will then contain the date in character form (Appendix IV Section 2).

1.8 DELETE

Delete subfile record (Section 4.4 of main text).

% DELETE <number>|<macro-time variable>

Delete the specified record from the currently selected subfile.

e.g. % DELETE #LREC

If #LREC is equal to 5 the fifth record of the currently selected subfile will be deleted.

1.9 DEPOSIT

Extension of deposit facility (Section 4.6.8 of main text).

% DEPOSITn <choice>$

The deposit facility (Appendix I Section 5.8) is extended so that <choice> may also include <argument reference>.

e.g. % DEPOSIT3 @2@$

Copy all the information in the second argument of the macro definition in which the statement occurs into string variable #S03 starting at the first available 'unfilled' character position of the string variable.

If the value for n is omitted the input buffer is used as the receiving string.

1.10 EXIT

Subroutine exit (Section 4.3 of main text).

% EXIT

Branch to the return address at the top of the stack and delete this entry from the stack. This statement is used to exit from a subroutine entered by the CALL statement (Appendix IV Section 1.1).

1.11 FREAD

Read subfile record (Section 4.4 of main text).

% FREAD <arg1>,<arg2>

<arg1>::= number | macro-time variable

<arg2>::= macro-time variable | string variable

From the currently selected subfile read the record specified by the first argument into the variable specified as the second argument.

e.g. % FREAD #LREC,#S01

If #LREC is equal to 4 then the fourth record of the currently selected subfile is read into string variable #S01.

1.12 FSTR

Fixed length string extraction (Section 4.6.1 of main text).

% FSTRm #Sn, {<macro-time variable> | <integer>},
{<macro-time variable> | <integer>}

This statement has the same function as CALLFSTR (Appendix I Section 7.4) except that the operation is performed on string n and the result is put in string m. If #Sn is omitted then the output buffer is used as the source string. If m is omitted the input buffer is used as the destination string.

e.g. FSTR2 #S01,1,10

Extract the first 10 characters from string variable #S01 and place them in string variable #S02.

1.13 IF

Extension of the IF statement facilities (Section 4.6.2 of main text).

The operators permitted with string expressions shown in Section 5 of Appendix I are extended as follows:

SOPR ::= EQ|NE|IN|AT|LE|LT|GE|GT

The new operators are shown below:

LE less than or equal to

LT less than

GE greater than or equal to

GT greater than

1.14 INSERT

Insert record in subfile (Section 4.4 of main text).

% INSERT <arg1>,<arg2>

<arg1>::= number|macro-time variable

<arg2>::= 'actual string'|macro-time variable|string variable

In the currently selected subfile, insert before the record indicated by the first argument the insertion record contained in the second argument.

e.g. % INSERT 3,#S03

Insert the record contained in string variable #S03 before the third record of the currently selected subfile.

1.15 MAINFILE

Set the name of the Mainfile to be used by the PG/2 macro processor (Section 4.7.3 of main text).

% MAINFILE,<mainfile name>

This statement is used to change the name of the mainfile when it is desired to reference a subfile not in the current mainfile.

1.16 PRINT

Empty the contents of the output stack on to the PG/2 output device (Section 4.5 of main text).

% PRINT

1.17 REPLACE

Replace subfile record (Section 4.4 of main text).

% REPLACE <arg1>,<arg2>

<arg1>::= number|macro-time variable

<arg2>::= macro-time variable|string variable

In the currently selected subfile, replace the record indicated by the first argument by the replacement record contained in the second argument.

e.g. % REPLACE #LREC,#S01

Replace the record indicated by the value in #LREC by the record contained in string variable #S01.

1.18 SAVE

Empty the contents of the output stack on to the specified subfile (Section 4.5 of main text).

% SAVE,<control code>,<subfile name>

Control code 0 = store the stack contents starting at the beginning of the named subfile

1 = append the stack contents to the end of the named subfile

N.B. This statement supercedes the statement with the same name in the PG/1 version (Appendix I Section 7.21).

e.g. % SAVE,0,SELCOND

Empty the output stack and store the contents at the beginning of the SELCOND subfile.

1.19 SELECT

Select subfile (Section 4.4 of main text).

% SELECT <arg>

<arg>::= subfile name|macro-time variable|string variable

Set the name of the subfile to which subsequent REPLACE, INSERT,

DELETE and FREAD statements will refer.

e.g. % SELECT CATALOGUE

Select the CATALOGUE subfile.

1.20 SQUASH

Extension of squash facility (Section 4.6.6 of main text).

% SQUASHn

The squash facility (Appendix I Section 7.22) is extended so that the operation is performed on string variable n. If n is omitted the operation is performed on the input buffer as before, but if n is equal to 0 the operation is performed on the output buffer. The number of characters in the result is stored in global variable #GSTC.

e.g. % SQUASH3

If #S03 initially contained 'A B C D' then its contents would become 'ABCD' and #GSTC will have the value 4.

1.21 SWAP

Interchange characters in a string variable (Section 4.6.5 of main text).

% SWAPn,<character>,<character>

Single or multiple occurrences of the left-hand character in string variable n are replaced by single occurrences of the right-hand character. If n is omitted the input buffer is used as the source string and if n is equal to 0 the output buffer is used as the source string. Global variable #GSTC is given an integer value equal to the number of characters in the resulting string.

e.g. % SWAP1,B,X

If #S01 initially contained 'AABBCCDD' then it will contain 'AAXCCDD' after the execution of the statement and #GSTC will

contain 7.

1.22 TIME

Obtain the current time from the operating system executive (Section 4.7.1 of main text).

% TIME

Global variable #GCTM will then contain the time in character form (Appendix IV Section 2).

1.23 VSTR

Variable length string extraction (Section 4.6.1 of main text).

% VSTRm #Sn, {<macro-time variable> | <integer>},
{<macro-time variable> | <integer>}

This statement has the same function as CALLVSTR (Appendix I Section 7.5) except that the operation is performed on string n and the result is put in string m. If #Sn is omitted then the output buffer is used as the source string. If m is omitted the input buffer is used as the destination string.

e.g. % VSTR1 #S03,4,X

Extract characters from string variable #S03 starting with the fourth character until an X character is detected and place them in string variable #S01.

2. ADDITIONAL RESERVED GLOBAL VARIABLES

The following variables are reserved within the PG/2 macro processor system and are additional to those listed in Section 8 of Appendix I. Their use and the statements which affect each are indicated.

CDT - (stands for Character form of DaTe) holds the date as eight characters in the form DD/MM/YY where:

DD represents a two digit day number

MM represents a two digit month number

YY represents a two digit year number

The value of this global variable is set during the execution of the DATE macro-time statement (Appendix IV Section 1.7).

CTM - (stands for Character form of TiMe) holds the time as eight characters in the form HH/MM/SS where:

HH represents a two digit hour number

MM represents a two digit minute number

SS represents a two digit second number

The value of this global variable is set during the execution of the TIME macro-time statement (Appendix IV Section 1.22).

3. NEW SYSTEM MACRO

%MAINFILE

The form of this command is:

%MAINFILE,⟨mainfile name⟩%

It causes the name of the mainfile referenced by the PG/2 macro processor to be changed (Section 4.7.3 of main text). The PG/2 macro processor contains a built in default value for the mainfile name, but this command causes the default value to be overwritten by the specified mainfile name.

e.g. %MAINFILE,NEXTFILE%

4. ADDITIONAL ERROR MESSAGES

The following error number messages replace or supplement those shown in Section 9 of Appendix I.

71 - Now applies to all file handling errors detected at the execution stage.

76 - In addition to the error indicated in Section 9 of Appendix I this error number now applies to all errors detected in the new macro-time statements at the compilation stage.

77 - This applies to all errors detected in the new PG/2 macro-time statements at the execution stage.

5. ADDITIONAL ARITHMETIC OPERATORS

The PG/1 macro processor range of simple arithmetic operations between integers and variables holding integer values (Appendix I Section 5) is extended to include multiplication and division. The operators for multiplication and division are denoted by the characters * and / respectively.

APPENDIX V

FORMATS OF COMMON DATA SUBFILES

APPENDIX V

FORMATS OF COMMON DATA SUBFILES

The format details of all the PG/2 macro processor common data subfiles used by the COBOL report program generating system are given in the order in which they are used. Where a subfile contains more than one record type the record formats are presented in the order in which they occur in the subfile. In records containing more than one field the comma is used as the field separator character.

The formats of the following subfiles are described:

1. CATALOGUE
2. RELATIONDICT
3. SUBMODEL
4. DOMAINDICT
5. KEYDICT
6. DOMAINLIST
7. DOMAININDEX
8. LABELTABLE
9. PAGEname
10. PICTUREDICT

1. CATALOGUE SUBFILE

1.1 CONTROL RECORD

Field No.	Contents	Type	Length	Max. Size	Comments
1	No. of File descriptions in the Catalogue	N	V	5	
2	No. of records in the Catalogue	N	V	5	
3	Catalogue Password	A	F	8	Any characters including blanks. Only used when adding or deleting file descriptions. Not used for read access.
4	No. of levels of security protection for read access to fields	N	V	2	Current maximum is 12, but may readily be increased to suit user's requirements.
5	Date of last Catalogue update	A	F	8	DD/MM/YY where DD = day number MM = month number YY = year number
6	Time of last Catalogue update	A	F	8	HH/MM/SS where HH = hours MM = minutes SS = seconds

Type: A = Alphanumeric, N = Numeric
Length; F = Fixed, V = Variable

Maximum record size including field separator characters = 42

1.2 FILE NAME RECORD TYPE 1

Field No.	Contents	Type	Length	Max. Size	Comments
1	File name	A	V	30	Must obey the rules for COBOL data-names.
2	No. of fields described in the Catalogue	N	V	4	Not all fields in the file need be included in the Catalogue.
3	Password-1	A	F	8	Highest security level.
4	Password-2	A	F	8	Security levels are entered in decreasing order.
5	Password-2	A	F	8	Used only if three or more levels of security are used in the Catalogue.
6	Password-4	A	F	8	Used only if four or more levels of security are used to protect the Catalogue data.

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 72

1.3 FILE NAME RECORD TYPE 1C

This record is present only if the number of security levels used to protect the Catalogue is greater than 4.

Field No.	Contents	Type	Length	Max. Size	Comments
1	Password-5	A	F	8	Only as many fields as are required by the security level system are present. Fields are in decreasing order of data sensitivity.
2	Password-6	A	F	8	
3	Password-7	A	F	8	
4	Password-8	A	F	8	
5	Password-9	A	F	8	
6	Password-10	A	F	8	
7	Password-11	A	F	8	
8	Password-12	A	F	8	

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 72

1.4 FILE NAME RECORD TYPE 2

Field No.	Contents	Type	Length	Max. Size	Contents
1	Description of file contents	A	V	70	The contents of this field is entirely at the user's discretion. A field separator character is not used to terminate this field.

Type: A = Alphanumeric
Length: V = Variable

Maximum record size = 70 characters

1.5 FILE NAME RECORD TYPE 3

Field No.	Contents	Type	Length	Max. Size	Comments
1	File medium	A	F	2	CR = cards, PT = paper tape, MT = magnetic tape, ED = exchangeable disc.
2	Maximum block size	N	V	4	$1 \leq$ Block size ≤ 2048
3	Maximum record size	N	V	4	$1 \leq$ Record size $\leq$ Maximum block size
4	File label	A	F	12	Only used for MT and ED files.
5	Access mode	A	F	1	Used only for ED files. S = sequential R = random
6	Organisation	A	F	1	Used only for random access ED files. D = direct I = indexed
7	Length of symbolic key	N	V	2	Used only for random access ED files. $1 \leq$ Length ≤ 64
8	No. of fields forming the symbolic key or sort key	N	V	1	$1 \leq$ Number ≤ 9

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 35

1.6 FIELD DESCRIPTION RECORD TYPE 1

Field No.	Contents	Type	Length	Max. size	Comments
1	Field name	A	V	14	Must obey the rules for COBOL data-names and not begin with a Z.
2	Security level	N	V	2	1 = Highest security level. 1 ≤ Level ≤ Value specified in Field 4 of the Catalogue Control record.
3	Start position	N	V	4	1 ≤ Start position ≤ Record size
4	Length of field	N	V	4	1 ≤ Length ≤ 120 and Start position + Length ≤ Record size
5	Field type	A	F	1	A = Alphanumeric N = Numeric
6	Decimal point location	A	V	4	L for Left or R for Right followed by up to 3 unsigned digits.
7	Key field indicator	N	F	1	1 ≤ Key no. ≤ Value specified in Field 8 of File name record type 3. 1 = major key field 0 = non-key field
8	Sequence order	A	F	1	A = Ascending D = Descending Used only for key fields.
9	Domain indicator	A	F	1	Y = Yes, N = No. Used for all fields except the major key.

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 41

1.7 FIELD DESCRIPTION RECORD TYPE 2

Field No.	Contents	Type	Length	Max. size	Comments
1	Description of field contents	A	V	70	The contents of this field is entirely at the user's discretion. A field separator character is not used to terminate this field

Type: A = Alphanumeric
Length: V = Variable

Maximum record size = 70 characters

2. RELATIONDICT SUBFILE

2.1 RELATION DICTIONARY RECORD

The subfile is maintained in ascending Relation name sequence.

Field No.	Contents	Type	Length	Max. size	Comments
1	Relation name	A	V	30	Must obey the rules for COBOL data-names and not begin with a Z.
2	Password	A	F	8	Password for the highest security level of data to which the user may have access.

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 40

3. SUBMODEL SUBFILE

3.1 CONTROL RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	No. of File descriptions in the Submodel	N	V	5	This will be less than or equal to the number of File descriptions in the Catalogue.
2	No. of records in the Submodel subfile	N	V	5	This will be less than or equal to the number of records in the Catalogue.

Type: N = Numeric
Length: V = Variable

Maximum record size including field separator characters = 12

3.2 FILE NAME RECORD TYPE 1

Field No.	Contents	Type	Length	Max. size	Comments
1	File name	A	V	30	The SUBMODEL file descriptions are maintained in File name order.
2	No. of fields described in the Submodel	N	V	4	This will be less than or equal to the no. of fields described in the Catalogue.

Type: A = Alphanumeric, N = Numeric
Length: V = Variable

Maximum record size including field separator characters = 36

N.B. There are no File name records of type 1C or 2 in the SUBMODEL subfile.

3.3 FILE NAME RECORD TYPE 3

Field No.	Contents	Type	Length	Max. size	Comments
1	File medium	A	F	2	This record is identical with its CATALOGUE subfile counterpart.
2	Maximum block size	N	V	4	
3	Maximum record size	N	V	4	
4	File label	A	F	12	
5	Access mode	A	F	1	
6	Organisation	A	F	1	
7	Length of symbolic key	N	V	2	
8	No. of fields forming the symbolic or sort key	N	V	1	

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 35

3.4 FIELD DESCRIPTION RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	Field name	A	V	15	The Field name from the CATALOGUE subfile with the possible addition of a numeric suffix for non-key fields whose names are also in another file.
2	Start position	N	V	4	These fields are identical to those in the corresponding Field description record type 1 in the CATALOGUE subfile.
3	Length of field	N	V	4	
4	Field type	A	F	1	
5	Decimal point location	A	V	4	
6	Key field indicator	N	F	1	
7	Sequence order	A	F	1	
8	Domain indicator	A	F	1	

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 39

4. DOMAINDICT SUBFILE

4.1 CONTROL RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	Domain count	N	V	5	Count of Domain description records in the DOMAINDICT subfile. A field separator character is not used to terminate this field.

Type: N = Numeric
Length: V = Variable

Maximum record size = 5 characters

4.2 DOMAIN DESCRIPTION RECORD

These records are maintained in ascending Domain name sequence.

Field No.	Contents	Type	Length	Max. size	Comments
1	Field name (Domain name)	A	V	15	The field name from the CATALOGUE subfile with the possible addition of a numeric suufix for non-key fields whose names are also in another file.
2	Length of field	N	V	4	
3	Field type	A	F	1	A = Alphanumeric N = Numeric
4	Decimal point location	A	V	4	L for Left or R for Right followed by up to 3 unsigned digits.
5	Key field indicator	N	F	1	0 = non-key field 1 = major key field
6	Sequence order	A	F	1	A = Ascending D = Descending Used only for key fields.
7	Domain indicator	A	F	1	Y = Yes, N = No. Used for all fields except the major key.

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 34

5. KEYDICT SUBFILE

5.1 KEY DICTIONARY RECORD

This subfile always contains nine records not all of which may be in use. The records are in major to minor key order and the number of records currently in use is given by the value in global variable #GNKEY.

Field No.	Contents	Type	Length	Max. size	Comments
1	Key domain name	A	V	14	This field is not terminated by a field separator character.

Type: A = Alphanumeric
Length: V = Variable

Maximum record size = 14 characters

6. DOMAINLIST SUBFILE

6.1 CONTROL RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	Domain count	N	V	5	Count of Domain description records in the DOMAINLIST subfile. Field separator omitted.

Type: N = Numeric
Length: V = Variable

Maximum record size = 5 characters

6.2 DOMAIN DESCRIPTION RECORD

These records are maintained in ascending Domain name sequence.

Field No.	Contents	Type	Length	Max. size	Comments
1	Field name	A	V	15	Domain name
2	Totalling marker	A	F	1	T = Totals required blank = Totals not required
3	Length of field	N	V	4	
4	Field type	A	F	1	A = Alphanumeric N = Numeric
5	Decimal point	A	V	4	L for Left or R for Right followed by up to 3 unsigned digits. Used only for numeric fields
6	Key field indicator	N	F	1	0 = non-key field 1 = major key field
7	Sequence order	A	F	1	A = Ascending D = Descending Used only for key fields.
8	Domain indicator	A	F	1	Y = Yes, N = No. Used for all fields except the major key.

Type; A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 36

7. DOMAININDEX SUBFILE

7.1 DOMAIN DESCRIPTION RECORD

This subfile is maintained in ascending Domain name sequence.

Field No.	Contents	Type	Length	Max. size	Comments
1	Domain or Item name	A	V	15	
2	Totalling marker	A	F	1	T = totals required blank = totals not required S = totals required for temporary item E = totals not required for temporary item
3	Length of field	N	V	4	
4	Field type	A	F	1	A = Alphanumeric N = Numeric
5	Decimal point location	A	V	4	L for Left or R for Right followed by up to 3 unsigned digits.
6	Key field indicator	N	F	1	0 = non-key item 1 = major key item
7	Sequence order	A	F	1	A = Ascending D = Descending Used only for key fields.
8	Domain indicator	A	F	1	Y = Yes, N = No. Used for all fields except the major key.

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 36

8. LABELTABLE SUBFILE

8.1 LABEL RECORDS

The file contains 19 records and is maintained in alphabetical order of Label character. Fields 2,3 and 4 are empty for unused Label characters.

Field No.	Contents	Type	Length	Max. size	Comments
1	Label character	A	F	1	The following are valid label characters: A E F G H I J K L N O Q T U V W X Y Z
2	Domain or Temporary item name	A	V	15	
3	Totalling marker	A	F	1	T = totals required blank = totals not required S = totals required for temporary item E = totals not required for temporary item
4	Field type	A	F	1	A = Alphanumeric N = Numeric

Type: A = Alphanumeric, N = Numeric
Length: F = Fixed, V = Variable

Maximum record size including field separator characters = 22

9. SUBFILES WHOSE NAMES HAVE THE PREFIX PAGE

9.1 CONTROL RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	Line count	N	V	2	Count of the number of line records in the subfile. Field separator omitted.

Type: N = Numeric
Length: V = Variable

Maximum record size = 2 characters

9.2 LINE RECORD

Field No.	Contents	Type	Length	Max. size	Comments
1	Line format	A	V	70	Non-blank line formats are as entered by the user but with the visible space (#) and text delimiter (") characters replaced by blanks. Blank lines, specified explicitly or by default, are denoted by a greater than character (>) in the first position. This is because the FREAD macro-time statement is unable to read blank, i.e. empty, subfile records. Field separator character omitted.

Type: A = Alphanumeric
Length: V = Variable

Maximum record size = 70 characters

10. PICTUREDICT SUBFILE

10.1 PICTURE DICTIONARY RECORD

This subfile is maintained in ascending Domain name order. The second field is not delimited by a comma separator character as this is a valid picture string character.

Field No.	Contents	Type	Length	Max. size	Comments
1	Domain or Temporary item name	A	V	15	
2	COBOL picture string	A	V	30	Field separator character omitted.

Type: A = Alphanumeric
Length: V = Variable

Maximum record size including the field separator character = 46

APPENDIX VI

LANGUAGE FACILITIES FOR COBOL GENERATION

APPENDIX VI

LANGUAGE FACILITIES FOR COBOL GENERATION

This appendix contains an initial attempt at defining the facilities of a high level language which are desirable for COBOL generation and is based on the experience gained while using the PG/2 macro processor. The material is presented under the following headings:

1. Basic structure
2. Data types
3. Input/Output
4. Program control and data manipulation
5. Error detection

1. BASIC STRUCTURE

1. Facilities for subroutines with names and arguments.
2. Overlay or chaining facilities.
3. Comments facility for annotating source code.
4. Access to assembly language subroutines, if necessary.

2. DATA TYPES

1. Integer and Real variables.
2. Variable length character strings.
3. Logical variables.
4. Global or Common variables.
5. Arrays with at least two dimensions.
6. Access to special operating system variables, e.g. date and time.
7. Use of literals - alphabetic, numeric and alphanumeric.

3. INPUT/OUTPUT

1. Efficient access to backing store files.
2. Sequential, random and/or indexed sequential access to records in backing store files.
3. Data editing facilities, e.g. insertion of currency symbols and punctuation characters etc.
4. Formatted and unformatted input/output.

4. PROGRAM CONTROL AND DATA MANIPULATION

1. Unconditional and conditional control statements.
2. Arithmetic expressions with operators for addition, subtraction, multiplication and division of variables.
3. Comparison operators for integer, real and character string variables, i.e. $=$, $\neq$, $>$, $\geq$, $<$ and $\leq$.
4. Logical operators AND and OR.
5. Numeric character conversion to real or integer and vice versa.
6. Variable and fixed length string extraction facilities.
7. Concatenation of strings.
8. String processing facilities for pattern matching.
9. Facilities for removing and/or replacing characters in strings.
10. Facilities for determining the length of a character string.
11. String class validation facilities, i.e. numeric, alphabetic or alphanumeric.
12. Macro expansion facilities for program generation (flexible templates).

5. ERROR DETECTION

1. Good diagnostics at compilation and execution time.
2. Error tracing facilities.

APPENDIX VII

COBOL REPORT GENERATING SYSTEM MACRO PROCESSING DETAILS

ILLUSTRATIONS

APPENDIX VII

COBOL REPORT GENERATING SYSTEM MACRO PROCESSING DETAILS

The material in this appendix supplements Chapter 7 of the main text by providing further details about the following:

1. Frequently used routines.
2. Validation of user responses.
3. Catalogue maintenance macros.
4. Problem specifying macros.
5. 'Grown' macro outlines.
6. Subfile usage.

All macros used during the problem specifying dialogue have one parameter which is always the % character. When macro definitions are 'grown' the parameter is used in the generation of system macro and macro-time statements (c.f. Section 3.6.2 of the main text). A change in the operating system used for the development of the COBOL generating system enabled @, the default parameter marker character, to be used (Appendix I Sections 3 and 6.1).

1. PROMPT ROUTINE

This routine issues a prompt character, reads the user's reply and detects a plea for help. The routine is present in all the problem specifying macros which require the user to enter a response.

The routine forces the operating system invitation to type character (←) on to a new line by writing out a colon character thus:

:←

The user then has up to 70 characters available for typing his response line. The response is read, the first five characters are extracted from the input buffer and tested to see if they are '%HELP'. If help has been requested the routine chains to the HELP macro, otherwise control returns to the statement following that which called the routine. The statement to which control is returned is usually the first of several which validate the response.

The listing of the STAGE2 macro (Item 18 in the separate folder) illustrates the use of this routine, the first statement of which is labelled 9000. In macros not in the same mainfile as the HELP macro, the CONTINUE statement with the label 9001 is replaced by the following:

```
%9001 MAINFILE,GWAC132-DATA
```

2. SEARCH ROUTINE

This routine carries out a binary search of the Domain dictionary looking for a particular domain or temporary item name.

The Domain dictionary subfile, DOMAININDEX, is held in alphabetical order of domain name, which occupies the first field of each record (Appendix V Section 7). The count of the number of records in the subfile is maintained in global variable #GDMCT.

The routine expects the name of the domain for which the search is being made to be stored in string variable #S09. The routine sets local variable #LIND equal to zero if the search is sucessful and equal to 1 if it is not.

A DOMAININDEX record is read and stored in string variable #S01, from which the domain name field is extracted into string variable #S02. Local variables #LLOW, #LHIGH and #LCUR are used to calculate the number of the record to be read.

If a search is unsuccesful, local variable #LLOW points to the position in the subfile where, if desired, a new record containing details about the #S09 domain may be inserted.

The listing of the STAGE5 macro (Item 22 in the separate folder) illustrates the use of this routine, which begins with the statement labelled 8000.

3. INVALID RESPONSE ROUTINE

This routine outputs the 'INVALID RESPONSE' message.

All user responses are validated and where possible a meaningful error message is output before the invitation to type is reissued. There are, however, many instances where a simple response of one or two characters is required. Here an error, if it occurs, is usually obvious and often only a typing error. In

such circumstances use is made of this routine which merely prints the words 'INVALID RESPONSE'. On return from this routine control is passed again to the prompt issuing statement, the label of which appears as the second parameter of the OBEY macro-time statement which initiated the call to the routine.

The listing of the STAGE5 macro (Item 22 in the separate folder) illustrates the use of this routine, which begins with the statement labelled 2100.

4. DEFAULT RESPONSE ROUTINE

This routine outputs the 'Default response' message.

During the course of the problem specifying dialogue there are many instances where a yes/no answer is required to a question. This routine, which instructs the user to enters his reply as a single character 'Y' or 'N' or to accept 'no' as the default reply, is called for this purpose.

The routine is illustrated in the listing of the STAGE5 macro (Item 22 in the separate folder) and begins at the statement labelled 2200.

5. LIBPRELIM MACRO

Further details of the five processing tasks of the LIBPRELIM macro are given below. On the listing of the macro (Item 14 in the separate folder) the beginning of each task has been highlighted.

1. The user is prompted to enter one of three valid options - ADD, DELETE or FINISH. Any other response by the user causes an error message to be output and the prompt is reissued.

2. The dialogue prompts the user to enter the name of the file whose description is to be added or deleted. The file name

is validated to ensure that it conforms with the COBOL rules for data-names (Table 5.1). An additional restriction, i.e. data-names may not begin with a Z, is imposed to avoid user file names duplicating those generated in the COBOL program which all have Z as a prefix. The user is only reminded of the rules for the formation of data-names when he infinges one of them. He is then prompted to enter a different name.

3. The user is prompted to enter the top security level password (level 1) for the file.

4. The File name type 1 records of the CATALOGUE subfile are searched to see if the user's file name is already in the Catalogue. The count of fields described in the current file description is extracted and used together with the number of security levels used to protect the Catalogue to calculate the number of the next record to be examined. As the Catalogue file descriptions are recorded in ascending file name order, the search stops when one of the following three conditions is satisfied:

The required file name is found.

All the Filename type 1 records in the CATALOGUE subfile have been examined without finding the required file name.

A file name greater than that entered by the user is found.

Global variable #GFERR is set equal to zero or 1 depending on whether or not the required file name is found. If the file name is located but the user has not supplied the correct level 1 password, global variable #GPERR is set equal to 1, otherwise it is set equal to zero. These global variables are interrogated in the LIBADD and LIBDELETE macros.

5. Control passes to the LIBADD or LIBDELETE macro depending on the option selected at the beginning of the LIBPRELIM macro. Global variable #GOPT contains the option chosen.

Table 5.1 COBOL rules for data-names

Not more than 30 characters long
No imbedded blanks
Only alphabetic, numeric and hyphen characters allowed
First and last characters may not be hyphens
At least one alphabetic character must be present

6. LIBDELETE MACRO

Further details of the processing tasks carried out by the LIBDELETE macro are given below. On the macro listing (Item 15 in the separate folder) the beginning of each task has been highlighted.

1. The Catalogue search carried out by the LIBPRELIM macro must have been successful, i.e. the #GFERR global variable used as the file name error indicator must contain zero. If a non-zero value is detected this indicates that the given file is not described in the Catalogue and a message to this effect is output on the user's terminal.

2. The user must have been able to supply the top security password (level 1) for the file in the LIBPRELIM macro, i.e. global variable #GPERR must contain zero. If a non-zero value is detected the user is advised that his password is unacceptable and that his request to delete the file description has been cancelled.

3. After the successful search of the CATALOGUE subfile in the LIBPRELIM macro, the record number global variable, #GREC, points at the first record of the file description to be deleted. The number of records to be deleted is a function of the number of fields described in the file and the number of security levels by which the Catalogue data is protected. The DELETE macro-time

statement is executed the required number of times by means of a program loop.

4. The file and record counts from the Catalogue Control record, which were stored in global variables #GFCT and #GRCT during the LIBRARIAN macro, are reduced appropriately. Their new values together with the Catalogue password, number of security levels and the current date and time are concatenated into a string variable which is used to replace the CATALOGUE subfile Control record.

5. The user is advised of the successful deletion by a message on his terminal.

6. No matter whether or not the request to delete a file description was successfully effected control is always returned to the LIBPRELIM macro, which permits processing to continue.

7. LIBADD MACRO

The processing tasks carried out by the LIBADD macro are give given in further detail below. The beginning of each task has been highlighted on the macro listing (Item 16 of the separate folder).

1. The Catalogue search carried out by the LIBPRELIM macro must have been unsuccessful, i.e. the #GFERR global variable used as the file name error indicator must be non-zero. A zero value indicates that the file with the given name is already in the CATALOGUE subfile and a message to this effect is output on the user's terminal.

2. On entry to the LIBADD macro #GREC, the global variable used as the record pointer, points to the position where the new file decription should be inserted. Throught the processing of the LIBADD macro this variable is incremented by 1 each time a record is inserted in the CATALOGUE subfile.

3. The file name and highest security level password for the file whose description is being added to the Catalogue were gathered during the LIBPRELIM macro. It therefore remains to request the user to supply the remaining data for the other fields of the File name records. The data for each field is suitably validated and concatenated into a string variable with the fields separated by commas. As soon as a File name record is complete it is entered into the CATALOGUE subfile, thus releasing the string variable for other use. As not all the fields in the File name records may apply to a particular file the dialogue is programmed so that only pertinent questions are asked. The comma separator character only is concatenated into the record to indicate an unused field. Although the dialogue gives the user some guidance about what constitutes a valid response, extensive validation of the user's replies is vital for the integrity of the Catalogue data. The nature and extent of the reply validation for the File name records data is given in Table 7.1 and their formats are shown in Section 1 of Appendix V.

4. As the number of fields in a record of the file currently being described was entered as data for the File name type 1 record, a processing loop is set up to gather data for each pair of Field description records. The data to be gathered about each field depends on its type, numeric or alphanumeric, and whether or not it is a sequence key field. The dialogue is again programmmed to pose only relevant questions and for unused fields only the comma separator character is concatenated into the record description. The dialogue prompts give the user guidance on the form of each reply which is then suitably validated. Details of the validation for Field description type 1 record data are given in Table 7.2. The type 2 Field description record is purely descriptive and requires no validation.

As each key field description is processed the key number is concatenated into string variable #S06.

5. When all the pairs of valid Field description records have been inserted into the CATALOGUE subfile it is necessary to check that all key fields have been allocated. The string variable #S06 contains the concatenated key numbers, which are single digits separated by commas. #S06 is inspected to see that it contains all the key numbers for the file. If any key number is found to be missing the whole file description is deleted from the Catalogue and an error message is output on the user's terminal.

6. The file and record counts from the Catalogue Control record, which were stored in global variables #GFCT and #GRCT during the LIBRARIAN macro, are incremented appropriately. Their new values together with the Catalogue password, number of security levels and the current date and time are concatenated into a string variable which is used to replace the CATALOGUE subfile Control record.

7. The user is advised by a message on his terminal that the file description has been sucessfully inserted in the CATALOGUE subfile.

8. No matter whether or not the request to add a file decsiption was sucessful control is always returned to the LIBPRELIM macro which permits processing to continue.

In task 4 above the user is encouraged to enter field descriptions in ascending start position order as this leads to more efficient processing. The savings are made later when the Catalogue data is used to generate a COBOL record description for the file. As the PG/2 macro processor has no sorting facility it is not possible to rearrange the Catalogue field description

records into start position order at a later date. At COBOL generation time a REDEFINES statement has to be generated whenever the start position of a field is not greater than the end position of the previous field described in the Catalogue (Appendix VIII Section 4).

The method of handling an error in task 5 above may seem rather drastic, but it is adopted because the LIBADD macro is already near to the size limit imposed by the PG/2 macro processor. Additional recovery processing would necessitate the subdivision of the LIBADD macro into several chained macros. While the restriction is reasonable in an 'experimental' implementation it does not prejudice the implementation of a more refined recovery procedure at a later date. The aim has been to provide the data base administrator with a simple tool for maintaining the Catalogue of file decriptions.

Table 7.1 Response validation for File name records data

Record Type	Field contents	Conditions to be satisfied
1	Number of fields in a record	String of up to four digits with value ≥ 1
2	Field description	None
3	File medium	2 character string with value: 'PT', 'CR', 'MT' or 'ED'.
	Maximum block size	String of digits with value ≥ 1 and ≤ 2048
	Record size	String of digits with value ≥ 1 and $\leq$ Maximum block size.
	File label	12 character string for ED and MT files only.
	Access mode	Single character with value 'R' or 'S' for ED files only.
	Organisation	Single character with value 'I' or 'D' for ED random access files only.
	Length of symbolic key	String of digits with value ≥ 1 and ≤ 64 for ED random access files only.
	Number of fields in symbolic or sort key	Single digit with value > 0

Table 7.2 Response validation for Field description record type 1 data

Field contents	Conditions to be satisfied by user's response
Field name	Character string with length ≤14. No imbedded blank characters. First character not Z or hyphen. Last character not hyphen. Consist only of alphabetic, numeric and hyphen characters. Contain at least one alphabetic character. Must not duplicate the name of another field already in the same File description.
Security level	A character string which must not contain a comma, but which must be a substring of that in string variable #S08. (String variable #S08 contains all the valid security level values separated by commas and was set up in the LIBRARIAN macro.)
Start position	String of digits with value ≥1 and ≤record size.
Length of field	String of digits with value ≥1 and ≤120. Start position + Length of field - 1 ≤ record size.
Field type	A single character; either 'A' or 'N'.
Decimal point location	Character string with the first character either 'L' or 'R'. Subsequent characters to be digits with value ≤99. (Only applicable to numeric fields.)
Key field indicator	A single character which must be present in string variable #S07. (String variable contains 0 and all the valid key number digits for the file.) If non-zero the character must not be present in string variable #S06. (String variable #S06 contains all the previously allocated key numbers for the current file.)
Sequence order	A single charcter; either 'A' or 'D'. (Only applicable to key fields.)
Domain indicator	A single character; either 'Y' or 'N'. (Applicable to all fields except the major key.)

8. STAGE3 MACRO

Thirteen main processing steps are carried out during the execution of the STAGE3 macro and their details are as follows. The first statement of each step is highlighted on the macro listing (Item 19 in the separate folder).

1. Set the global variable used to contain the check point number (#GCKPT) equal to 3.

2. Print out the Stage 3 introductory dialogue which is stored in the DIAL3 subfile. This text advises the user that he is about to be shown details of the domains within the relations of his data base. It goes on to explain with illustrations the notation used to indicate the position of the decimal point in a numeric field.

3. Establish details of the Catalogue characteristics by reading the data in the Catalogue Control record.

4. Carry out the housekeeping operations necessary to maintain pointers to the current record in the subfiles used by the macro, keep count of the number of files described in the SUBMODEL subfile, and count the number of fields described in the current SUBMODEL file description.

5. For each relation named in the RELATIONDICT subfile the CATALOGUE subfile is searched to see if there is a matching file description. Both subfiles are maintained in relation name (file name) sequence. When no matching name is found the error indicator is set, the user is advised that the relation is not in the data base and the search for the next relation in the Relation dictionary is begun. When a relation has a matching description in the Catalogue its name and the column headings for the domain details are printed.

6. The user supplied password from the RELATIONDICT record

is matched against the passwords in the Catalogue File description type 1 record to determine which security levels the user may access. If the Catalogue has more than four security levels it may be necessary to search the passwords in the type 1C record to obtain a match. When no matching password can be found the error indicator is set, the user is advised that as the password is invalid no domains are accessible and the search for the next relation in the Relation dictionary begins.

7. The Catalogue File name type 3 record is read and it is copied on to the SUBMODEL subfile after the shortened form of the type 1 record.

8. The Field description type 1 records of the current Catalogue file description are read in turn and checked to see if the user has password access to the field (domain). The security level of the field must be greater than or equal to the level set by the user's password in step 6 above.

9. For each Field description record to which the user is allowed access, the remaining fields are extracted into local variables ready for later use. The DOMAINDICT subfile, which is maintained in domain name sequence, is searched to see if the current field name (domain name) is already in the Domain dictionary. If it duplicates a dictionary entry and is not a key field then the ambiguity is resolved by appending the relation count as a suffix to the field name. The field name is padded out with relation count digits until is is 15 characters long. The details of the renamed field are inserted in the DOMAINDICT subfile. If the field name is not found in the Domain dictionary then its details are inserted in the DOMAINDICT subfile. Prior to that, if it is a key field, its name would have been entered in the KEYDICT subfile. This latter subfile is maintained in key number sequence and global variable #GNKEY contains the subfile record

count.

10. The current Catalogue Field description type 1 record to which the user has password access is copied to the SUBMODEL subfile. The details of name, size, type, and decimal point location, if applicable, are output to the user's terminal.

11. When all the field description records in the current Catalogue File description have been processed, the field count in the current Submodel File description record type 1 is updated. Only if the user has password access to all the fields in the file description will this be the same as it was in the Catalogue.

12. The domain names in the KEYDICT subfile for the current relation are output on the user's terminal in major to minor key order.

13. When all the relations in the KEYDICT subfile have been processed without error, the control records for the SUBMODEL and DOMAINDICT subfiles are written and control passes to the STAGE3-1 macro by means of the chain facility. If, however, the error indicator has been set a message is output to the user's terminal advising him that the error prevents further progress. The user is then given the choice of abandoning the run or returning to the STAGE2 macro to respecify the relation names and passwords.

The error handling facilities in this macro show potential for enhancement. A useful extension would be to list on the user's terminal the relation names and passwords entered in Stage 2 under three categories:

1. Invalid relation names.
2. Valid relation names with invalid passwords.
3. Valid relation names and passwords.

Facilities could then be provided so that only corrections to entries in the first two categories need be made before resuming the processing.

9. STAGE3-1 MACRO

This macro checks that the relations named by the user in Stage 2 are not disjointed or disconnected according to the criteria outlined in Section 6.4.2 of the main text. If only one relation was named in Stage 2 then this macro immediately chains to the STAGE4 macro. The checking process is carried out in six steps described below. On the macro listing (Item 20 in the separate folder) the statement at which each step begins has been highlighted.

1. The SUBMODEL subfile Control record is read in order to establish the number of file descriptions and records contained therein.

2. Local variables are set up for use as pointers and counters to keep track of the current record in the subfiles used by the macro. Global variable #GNKEY is initially set to zero, ultimately it will contain the number of key domains in the joined relations.

3. A pass is made through the SUBMODEL subfile to extract and examine the pairs of File description records in order to establish which of the described files has the greatest number of key fields. When the number of keys in the current file description exceeds the value in #GNKEY its value is updated and the position of the file description within the SUBMODEL subfile is noted. The field description records for this file are examined and the key field names are extracted and stored in the KEYDICT subfile in major to minor key order.

4. A second pass through the SUBMODEL subfile is made in order to comapre the key details all file descriptions, other than the one noted during pass one, with the contents of the KEYDICT subfile.

5. If the key field names of any of the files do not form an ordered contiguous subset of those in the Key dictionary, the relations are deemed to be disjointed or disconnected. If this condition is detected a message is output on the user's terminal telling him that his relations cannot be joined. He is then given the opportunity to return to Stage 2 to respecify the relation names and passwords or to abandon the run.

6. If no errors are detected during the processing of this macro control chains to the STAGE4 macro.

At present little is done in the STAGE3-1 macro to help the user if the relations he specifies are found to be disjointed or disconnected. He can only seek advice from the data base administrator, Future enhancements could include the output of a list of those relations which cannot be joined, together with details of the key domains which cause them to be disjointed or disconnected. Only details of these latter relations need then be changed before processing resumes with the STAGE2 macro.

10. STAGE4 MACRO

The processing carried out by the STAGE4 macro falls into twelve main steps which are described below. On the macro listing (Item 21 in the separate folder) the statement at which each step begins has been highlighted.

1. Set the check point variable #GCKPT equal to 4, ready in case the restart facility is invoked by a call for 'help' by the user.

2. Output the introductory text for this stage which is stored in the DIAL4 subfile.

3. Set up and initialise local variables for use as record pointers to the DOMAINDICT and DOMAINLIST subfiles.

4. Create and set to zero the global variable #GTOT which is used to indicate whether or not the totalling facility is required.

5. Select the DOMAINDICT subfile, read the Control record, extract and convert to binary the count of domain records stored in the subfile.

6. Read the domain description from the DOMAINDICT subfile, record by record, and extract the fields for processing.

7. The name of each domain in turn is displayed to the user who is asked to indicate, by a yes or no reply, whether it is required to solve the problem.

8. For each numeric domain which features in the problem the user is additionally asked if the totalling facility is required for it. Again a yes/no answer is called for.

9. When the totalling facility is invoked for any numeric domain the global variable indicator #GTOT is set equal to 1.

10. Of the domains which are required to solve the problem, the alphanumeric and non-totalling numeric ones have their details written to the DOMAINLIST subfile with the totalling marker set to a blank character. Numeric domains for which totalling is required have the totalling marker set equal to the character 'T'. In addition details of key domains not required to solve the user's problem are by default entered in the DOMAINList subfile with a blank totalling marker. Their details are required when the complete COBOL program is generated.

11. A count of domain records written to the DOMAINLIST subfile is maintained. When all the domains in the DOMAINDICT subfile have been processed, the value of this count is stored in the Control record of the DOMAINLIST subfile.

12. The final task is to chain to the STAGE5 macro.

11. STAGE5 MACRO

The processing within this macro consists of the steps shown below. The first statement of each step is highlighted on the macro listing (Item 22 in the separate folder).

1. Set the global check point variable #GCKPT equal to 5, ready for restart procedures in invoked by the user's request for help.

2. Print the introductory dialogue which describes the facilities available in Stage 5. The text of this dialogue is stored in subfile DIAL5.

3. Select the DOMAINLIST subfile, read the Control record and convert the domain count into binary. This count is stored in global variable #GDMCT and from it the number of the last record in the DOMAINLIST subfile may be calculated.

4. Set up and maintain record pointers for both the DOMAINLIST and DOMAININDEX subfiles.

5. Copy all the domain description records in the DOMAINLIST subfile to DOMAININDEX.

6. Generate the first two statements of the TEMPITEM macro definition.

7. Ask if the user wishes to create any temporary items. If the reply is 'no' then control passes to the STAGE5-2 macro by means of the chain facility. Otherwise, processing continues as outlined below.

8. The user wishes to create temporary items, so he is now asked if any of them contain alphanumeric data. If the reply is in the negative the chain facility passes control to the STAGE5-1 macro. Otherwise, details of the alphanumeric items are gathered in the manner indicated below.

9. Request the name of the new alphanumeric item and validate the user's reply. The name must satisfy the COBOL rules

for a data-name (Table 5.1 of this appendix) and two additional conditions imposed by the COBOL generating system. First, that the name must not exceed 14 characters in length and secondly, that it must not begin with the character 'Z'.

10. The user entered name must be unique, so a binary search of the names in the records of the DOMAININDEX subfile must be carried out in order to establish this. Steps 9 and 10 are repeated until the user enters a unique valid name.

11. The user is asked to state how many characters the new alphanumeric item contains. The reply must be a number in the range 1 to 58 with a default value of 30. The upper limit is less than that permitted by COBOL and the reason for the restriction is explained in step 14.

12. The initial value of the alphanumeric item may be set by the user, so he is asked if he wishes to avail himself of the facility. If the reply is 'yes' then the user is prompted to enter the value. Otherwise, the initial value is set, by default, to contain blanks.

13. All the information necessary to set up and insert a description record for the new item in the DOMAININDEX subfile is to hand. The insertion position for the record is stored in local variable #LLOW as a by-product of the binary search carried out in step 10 above. The domain count variable #GDMCT is also incremented by 1.

14. Finally, the data description entry for the new alphanumeric item is generated. In order to avoid the special coding necessary when a COBOL literal continues onto another line, the maximum size of a temporary item is limited to 58 characters. This is the largest literal, including quotation mark delimiters and the final full stop character, which can be

accomodated between positions 12 and 72 of a COBOL statement. The generated COBOL statements have the following form:

02 temporary-item-name PICTURE X(item-size) VALUE "initial-value".

15. Steps 9 to 14 are repeated until the user gives a negative reply when asked if he has any more alphanumeric items to create. Control then passes to the STAGE5-1 macro by means of the chain facility.

12. STAGE5-1 MACRO

In this macro for creating temporary numeric domains, the processing is carried out as shown below. On the macro listing (Item 23 in the separate folder) the first statement of each step has been highlighted.

1. Ask the user if he wishes to create any temporary numeric items. If the reply is 'no' then control passes to the STAGE5-2 macro by means of the chain facility. Otherwise, the processing continues as outlined below.

2. The name of the numeric item is requested and validated in a similar way to that described in steps 9 and 10 of the STAGE5 macro.

3. The user is asked to state how many characters the numeric item contains. The reply must be a number in the range 1 to 60, with a default value of 18. The upper limit is less than that permitted by COBOL, but it is the largest size which, together with the full stop character, can be accomodated in one line of COBOL coding (c.f. STAGE5 step 14).

4. The location of the decimal point within the numeric item is established by asking the user to indicate its position relative to the right-most digit. The direction is specified by

a single character, 'L' for left or 'R' for right. The displacement must be entered as a single digit, i.e. in the range 0 to 9, with a default value of zero. This is an arbitrary restriction which could be relaxed at a later date should circumstances require.

5. The user is asked if he wishes to enter an initial value for the temporary numeric item. The default reply is 'no', in which case the item is initially set to zero. If the user replies 'yes' he is prompted to enter the initial value. The response is validated to ensure that it obeys the rules for a COBOL numeric literal (Table 12.1 of this appendix).

6. The automatic totalling option is available for temporary numeric items, so the user is invited to state if he wishes to avail himself of the facility. The default reply is 'no'. If totalling is required, the global variable totalling indicator, #GTOT, is set equal to 1 and the local variable used as the totalling marker for the item is set equal to 'S'. If totalling is not required, the totalling marker is set equal to 'E'.

7. All the information necessary to set up and insert a description record for the new temporary numeric item in the DOMAININDEX subfile is to hand. The record insertion position was set during step 2 above (c.f. STAGE5 macro). The domain count in global variable #GDMCT is incremented by 1.

8. The COBOL data description entry for the new numeric item can now be generated and takes the following form:

02 temporary-item-name PICTURE picture-string COMPUTATIONAL VALUE initial-value.

Depending on the item size and the location of the decimal point, one of five picture strings is generated. These details are summarised in Table 12.2 of this appendix.

9. Steps 2 to 8 are repeated until the user gives a negative

reply when asked if he has any more numeric items to create. The processing in the latter part of step 1 is then carried out.

Table 12.1 Rules for a COBOL numeric literal

Not more than 60 characters long.
First character '+' or '-' or a digit (0 to 9).
Subsequent characters must be digits or a decimal point.
After a decimal point only digits are permitted.
The decimal point may not be the last character.

Table 12.2 Picture strings for numeric items

Decimal point location	Picture-string
1. Within the string of digits.	S9(n)V9(m)
2. Immediately after the last digit.	S9(l)
3. One or more positions to the right of the last digit.	S9(l)P(m)V
4. One or more positions to the left of the first digit.	SVP(p)9(l)
5. Immediately before the first digit.	SV9(l) where l = item size m = decimal point shift count n = l - m and p = m - l

13. STAGE5-2 MACRO

The processing in the STAGE5-2 macro is carried out as shown below. On the macro listing (Item 24 in the separate folder) the first statement of each step has been highlighted.

1. The statements for the TEMPITEM macro generated during the execution of macros STAGE5 and STAGE5-1 are saved in the TEMPITEM subfile. The first two statements for the CONCAT macro are generated and saved in the CONCAT subfile.

2. The remaining text in the DIAL5 subfile, which describes the concatenation of domains, is output and the user is asked if he wishes to create any compound domains. If the user replies 'yes', then processing continues at step 3. Otherwise, the final statements for the CONCAT and TEMPITEM macros are generated and filed and control chains to the STAGE6 macro.

3. The name of the compound domain is requested in a similar way to that described in steps 9 and 10 of the STAGE5 macro.

4. A count of the number of characters in the compound domain is maintained in local variable #LCHCT and this is initially set equal to zero.

5. A copy of the binary search record pointer, used in step 3 above, is saved in a local variable. It is used later in step 11 when the compound domain description is inserted in the DOMAININDEX subfile.

6. The COBOL level 02 data description statement for the group item is generated and appended to the TEMPITEM subfile. The generated statement has the following form:

02 compound-domain-name.

7. The user is requested to enter the name of a domain to be concatenated. A binary search of the names in the DOMAININDEX subfile is then made to check that the domain exists within the user's data base. If the domain name cannot be found the user is

advised and another name must be entered.

8. The size of items in the domain to be concatenated is extracted from its DOMAININDEX record, converted to binary and stored in a local variable. This value is added to the variable created in step 4 above for maintaining the compound domain size.

9. The COBOL level 03 data description for the domain being concatenated to form the compound domain is generated and appended to the TEMPITEM subfile. The statement generated has the form:

03 domain-name PICTURE X(item-size).

10. The Procedure division MOVE statement which transfers data from the individual item to the corresponding sub-item of the group is generated and appended to the CONCAT subfile. The generated statement occupies two lines and has the following form:

MOVE domain-name IN Z-TUPLE TO domain-name IN
compound-domain-name IN Z-TUPLE.

11. Steps 7 to 10 are repeated until the user has no more domains to include in the current compound domain. The compound domain description record is then set up and inserted in the DOMAININDEX subfile at the position determined in step 5 above. Also the domain count in #GDMCT is incremented by 1.

12. For the information of the user the size of the newly created compound domain is displayed on the user's terminal.

13. Steps 3 to 12 are repeated until the user gives a negative reply when asked if he has any more compound domains to create. The processing described in the latter part of step 2 is then carried out.

14. STAGE6 MACRO

The following steps give details of the STAGE6 macro processing. On the macro listing (Item 25 in the separate folder) the first statement of each step has been highlighted.

1. The check point variable #GCKPT is set equal to 6 ready in case the 'help' facility is invoked.

2. If the number of relations (#GNREL) required to solve the user's problem is equal to 1, control passes to step 9. Otherwise, processing continues below.

3. Part of the descriptive text stored in the DIAL6 subfile is printed on the user's terminal. This describes the options open to the user when a data inconsistency occurs during the execution of the COBOL program. The user is then prompted to select an option.

4. The user's response is validated and if the default option was selected the value is specifically set equal to 1. The option number is converted to binary and stored in global variable #GOPT for use in a later stage.

5. The user is asked to indicate if he wishes to have a message printed by the COBOL program when a mismatch condition is detected in the data files. The user's reply is validated and stored in global variable #GMOP. If the reply is explicitly or by default 'no' control passes to step 9, otherwise processing continues below.

6. The remaining text in the DIAL6 subfile is printed. This describes the form and content of the error message and asks the user if he wishes to specify some text of his own for inclusion in the message.

7. The user's response to the above question is validated and interpreted. When the default message is selected this is set up and stored in string variable #S05 and control passes to step 9, otherwise processing continues below.

8. As the user has opted to include his own text in the program error message, he is prompted to enter up to 20 characters. Like the default message these characters are stored in string

variable #S05.

9. The chain facility passes control to the STAGE7 macro.

15. STAGE7 MACRO

The processing in the STAGE7 macro is as set out below. On the macro listing (Item 26 in the separate folder) the first statement of each step has been highlighted.

1. Set the check point variable #GCKPT equal to 7.

2. Generate the first two statements of the SELCOND macro which will contain the COBOL selection condition statements, if any, for data retrieval.

3. Ask the user if he wishes to select only certain items for retrieval from his domains. If the reply is 'no', then processing continues at step 7 below.

4. As the user wishes to select only certain items from his domains the text in the DIAL7 subfile is printed. This text explains the use of simple and compound conditions and defines the syntax to be used for specifying a simple condition.

5. Call the Specify Condition routine (Section 15.1 of this appendix) to carry out the dialogue which prompts the user to enter his conditions for data retrieval. From the user's responses the appropriate COBOL conditional clauses are generated.

6. Generate the COBOL statements which specify the actions to be taken when the condition is satisfied and when it is not.

7. Generate the final statements for the SELCOND macro, save them all in the SELCOND subfile and chain to the STAGE8 macro.

The output of the instructional text in step 4 could be made optional for more experienced users of the system (Section 8.4 of the main text).

15.1 SPECIFY CONDITION ROUTINE

This routine carries out the condition specifying dialogue which consists of the following tasks:

1. Generate the COBOL 'IF' word.

2. Ask the user if he wishes to specify a compound condition. If his reply is 'yes' continue processing at step 7 below.

3. Ask the user to enter the simple condition.

4. Issue the prompt and read the user's condition entry.

5. Call the Validate Condition routine (Section 15.2 of this appendix) to validate the simple condition. It will either generate the equivalent COBOL condition clause or print an error message and set a local variable error indicator equal to 1. In the latter case processing resumes at step 4 above, in the former case it continues below.

6. Exit from the dialogue routine.

7. Set a local text variable equal to 'FIRST'. This text variable is used in the condition request message and takes the value 'FIRST' or 'NEXT'.

8. Ask the user to enter the first or next condition as appropriate.

9. Issue the prompt and read the user's condition statement.

10. Call the Validate Condition routine to validate the condition. If an error is detected processing resumes at step 9 above, otherwise it continues below (c.f. step 5).

11. If the local text variable is equal to 'FIRST' continue at step 13, otherwise continue below.

12. Ask the user if he has any more clauses to enter. If the reply is 'no' resume processing at step 6 above, otherwise continue at step 14 below.

13. Change the contents of the local text variable to be

'NEXT'.

14. Ask the user to specify which conjunction, 'AND' or 'OR', precedes the next simple condition and generate a COBOL statement containing the selected conjunction. If the 'OR' conjunction is specified the user is reminded that he must re-enter any of the previously entered conditions which still apply (Section 5.5.3 of main text). Processing resumes at step 8 above.

15.2 VALIDATE CONDITION ROUTINE

This routine validates the user's simple condition statement which is located in the input buffer and from it generates the equivalent COBOL statement. The COBOL statement occupies two lines in order to allow for the qualification of data-names and takes the form:

```
operand-1 IN Z-TUPLE conditional-operator
operand-2 IN Z-TUPLE
```

The qualification in the second line is omitted if operand-2 is a literal.

When an error is detected a message is output on the user's terminal, the local variable used as an error indicator is set equal to 1 and control returns to the calling routine without the generation of the COBOL statement. An error recovery procedure is carried out in the Specify Condition routine, the calling routine, when the error indicator is found to be equal to 1.

The processing steps are as follows:

1. Set the local varibale used as the error indicator equal to zero.

2. Validate the syntax of the simple conditional statement and separate the three components. The operands are stored in string variables and the operator is stored in a local variable. Processing and storage details are summarised in Table 15.1.

3. Validate the first operand which must be a domain or temporary item name. Processing details are given in Table 15.2.

4. Validate the operator and build up the equivalent COBOL operator in a string variable. Processing details are given in Table 15.3.

5. Save, in a local variable, the type of the first operand, either numeric or alphanumeric. The type is determined in step 3 above and is used again in step 8.

6. Determine the length of the second operand and place a copy of the operand into the input buffer ready for validation.

7. Identify the nature of the second operand by inspection of the first character of the input buffer and validate accordingly. Processing details are given in Tables 15.4 to 15.7.

8. Compare the type, alphanumeric or numeric, of the first and second operands. If they are not the same an error message is output on the user's terminal, the error indicator is set equal to 1 and processing continues at step 10.

9. Generate the COBOL condition statement using the preset contents of selected string variables.

10. Exit from the routine.

Table 15.1 Syntax validation for a Simple Condition located in the input buffer

Conditions to be satisfied	Actions to be take when all conditions are satisfied
1. Both full stop delimiters for the operator must be present. 2. The second full stop delimiter must not be the last non-blank character in the input buffer.	1. Extract operand-1 and store in string variable #S03. 2. Extract the operator, omitting the delimiters, and store in local variable #LOP. 3. Extract operand-2 and store in string variable #S04.

Table 15.2 Validate 1st Operand as a domain or temporary item name

Actions to be taken before validation	Conditions to be satisfied
1. Make a copy of the operand name in string variable #S09. 2. Binary search the DOMAININDEX subfile for a name matching that in #S09. N.B. An extended version of the Search routine (Section 2 of this appendix) is used which enables the type of field to be extracted from the DOMAININDEX subfile record and stored in local variable #LTYPE.	1. The binary search success indicator, #LIND, must be zero.

Table 15.3 Validate Condition Operator

Action to be taken before validation	Permitted values of condition operator in #LOP	Equivalent COBOL condition set up in string variable #S08
1. Remove any imbedded blanks in the operator by squashing the contents of local variable #LOP.	EQ	EQUAL TO
	LT	LESS THAN
	LE	NOT GREATER THAN
	GT	GREATER THAN
	GE	NOT LESS THAN
	NE	NOT EQUAL TO
	NOTEQ	NOT EQUAL TO
	NOTLT	NOT LESS THAN
	NOTLE	GREATER THAN
	NOTGT	NOT GREATER THAN
	NOTGE	LESS THAN
	NOTNE	EQUAL TO

Table 15.4 Identify nature of Second Operand

1st character	Operand type
"	Alphanumeric literal
+ - . or digit	Numeric literal
Any other character	Domain or temporary item name

Table 15.5 Validation of Alphanumeric literal 2nd Operand

Conditions to be satisfied	Actions to be taken when all conditions are satisfied
1. Length ≥3 2. Last character a double quotation mark (").	Set local variable #LTYPE equal to 'A' to denote that the second operand is of alphanumeric type.

Table 15.6 Validation of Numeric literal 2nd Operand

Conditions to be satisfied	Action to be taken when all conditions are satisfied
1. Subsequent characters must be digits or a decimal point. 2. After a decimal point only digits are permitted. 3. The decimal point may not be the last character.	Set local variable #LTYPE equal to 'N' to denote that the second operand is of numeric type.

Table 15.7 Validation of Domain or Temporary item as 2nd Operand

Actions to be taken before validation	Conditions to be satisfied	Action to be taken when conditions are satisfied
1. Make a copy of the operand name in string variable #S09 2. Binary search the DOMAININDEX subfile for a name matching that in #S09, N.B. An extended version of the Search routine (Section 2 of this appendix) is used which enables the field type to be extracted from the DOMAININDEX subfile record and stored in local variable #LTYPE.	1. The binary search success indicator, #LIND, must be zero.	1. Append the qualification IN Z-TUPLE to the name of the second operand which is stored in string variable #S04.

16. STAGE8 MACRO

The processing steps for the STAGE8 macro are shown below. On the macro listing (Item 27 in the separate folder) the first statement of each step has been highlighted.

1. Set the check point variable #GCKPT equal to 8.

2. Print the introductory dialogue for the stage and ask the user to select the report page width. Although a narrow page of 70 characters or a wide page of 120 characters is offered, only the implementation of the narrow page has been attempted. Global variable #GWDTH is used to store the user's option as a single character, 'N' for a narrow page or 'W' for a wide page. (A user selecting a wide page is told that the facility is not yet available and by default a narrow page is assumed.)

3. Ask the user to enter the maximum number of lines to be

printed on a report page. This must be a number in the range 40 to 99, with a default value of 60. Global variable #GMXLN is used to store in binary form the maximun number of lines on a report page.

4. Print the dialogue asking the user if he wishes to design his own report line formats or to accept the default formats generated by the system. (The default option has not yet been implemented so anyone selecting this option is advised that he must design his own output formats.)

5. Print the text describing how to select and associate a label character with each domain or temporary item appearing in the report.

6. Carry out the housekeeping operations necessary to maintain strings of valid and unallocated label characters and pointers to current records in the subfiles used by the macro.

7. Display, one by one, the names of the domains and temporary items in the DOMAININDEX subfile and ask the user to assign a unique label character to those which are to appear in the printed report.

8. Use the data from the DOMAININDEX record to set up and write the LABELTABLE record for the currently selected label character.

9. Steps 7 and 8 are repeated until either all the names in the DOMAININDEX have been displayed or all the label characters have been allocated. In the latter case a warning message is output.

10. Write LABELTABLE records for all unused label characters, if any, so that all fields except the first are empty.

11. Print the remaining instructional text from the DIAL8 subfile. This explains how to specify a report line format using label characters.

12. Chain to the STAGE9 macro.

17. STAGE9 MACRO NOTES

These notes should be read in conjunction with Figure 7.20 in the main text of the thesis. The note numbers refer to the block with the corresponding number in the figure.

1. The string of all valid label characters is set up in string variable #S03.

2. The user is prompted to enter an alphanumeric editing format which is saved in string variable #S04. The contents of #S04 is validated according to the rules shown in Table 17.1. The user is then prompted to enter the alphanumeric value to be edited according to the previously defined format. The characters entered are transferred to the output buffer according to the rule shown in Table 17.2.

3. Prompted by the dialogue the user enters a numeric editing format which is stored in string variable #S04 and validated according to the rules shown in Table 17.3. The numeric literal which the user is then prompted to enter must satisfy the conditions set out in Table 12.1 of this appendix. The edited form of the numeric literal is built up in the output buffer using the character manipulations described in Tables 17.4 to 17.6.

4. A copy of the check point variable #GCKPT is saved in local variable #LV1. #GCKPT is then reduced by 1 so that, when control chains to the stage designated by #LV1, the stage appears to have been entered normally.

Table 17.1 Validate Alphanumeric editing format

Conditions to be satisfied by Alphanumeric editing format stored in string variable #$04
1. The string of edit format characters must not contain imbedded blank or # characters, although it may begin with one or more # characters. 2. The label charcters in the string must all be the same. 3. The label character must be one of the those contained in string variable #$03. 4. In addition to the label characters and any leading # characters, only B and 0 characters may be present in the editing format. If present, the B or 0 characters must appear somewhere to the right of a label character, but not in the last character position.

Table 17.2 Character transfers to the output buffer during an Alphanumeric Edit

Edit characters from string variable #$04	Character deposited in the output buffer
#	% (i.e. blank)
Label character	Next character from the alphanumeric value located in the input buffer. (The buffer is scanned from left to right.)
B	% (i.e. blank)
0	0

Table 17.3 Validate Numeric editing format

Conditions to be satisfied by Numeric editing format stored in string variable #S04
1. The string of edit format characters must not contain imbedded blank or # characters, although it may begin with one or more # characters.
2. + or - may appear only once and may only be preceded by a # character.
3. $ or £ may appear only once and may only be preceded by a # + or - character.
4. * may only appear once and may only be preceded by a # + - $ or £ character.
5. The label characters in the string must all be the same.
6. The label character must be one of those contained in string variable #S03.
7. . may appear only once, but not as the last character in the string. It must be preceded by a least one label character.
8. CR and DB may appear as the last two characters of the edit format, but not if + or - have been used.
9. B , 0 characters may be present, but only if they are somewhere to the right of a label character and not in the last position of the edit string.
10. Excluding leading # characters the edit format string must not exceed 30 characters in length.

Table 17.4 Character transfers to the output buffer during a Numeric Edit - Part 1

Characters to the left of the implied or specified decimal point, reading from right to left	
Edit character from string variable #S04	Character deposited in the output buffer
.	.
Label character	Next digit from the numeric value located in the input buffer. (The buffer is scanned from right to left, starting with the character to the left of the implied or specified decimal point.) If the input buffer digits have all been processed or a sign character is reached, then a 0 character is used.
+	+ if the numeric value in the input buffer is positive or unsigned. - if the numeric value in the input buffer is negative.
-	- if the numeric value in the input buffer is negative. % (i.e. blank) if the numeric value in the input buffer is positive or unsigned.
£ or $	£ or $
*	*
B	% (i.e. blank)
,	,
0	0
#	% (i.e. blank)

Table 17.5 Character transfers to the output buffer during a Numeric Edit - Part 2

Characters to the right of the implied or specified decimal point, reading from left to right	
Edit character from string variable #S04	Character(s) deposited in the output buffer
Label character	Next character from the numeric value located in the input buffer. (The buffer is scanned from left to right, starting with the character to the right of the implied or specified decimal point.) If the character is blank, i.e. the input value characters are exhausted, a 0 character is used.
B	% (i.e. blank)
,	,
0	0
CR or DB	If the input buffer contains a positive or unsigned value %% is used (i.e. 2 blanks). If the input buffer contains a negative value the CR or DB characters are used.

Table 17.6 Adjustments to the contents of the output buffer prior to printing edited numeric data

Conditions to be satisfied by the contents of the output buffer	Action to be taken to amend the contents of the output buffer when the conditions are satisfied
None of the following edit characters present + - £ *	Replace all leading zeros, if any, up to but not including a zero immediately to the left of the implied or actual decimal point by blank characters.
* present	Replace all leading zeros, if any, to the right of the * character up to, but not including, a zero to the left of the implied or actual decimal point by a * character.
£ or £ present but * absent	1. Replace all leading zeros, if any, to the right of the £ or £ character up to, but not including, a zero to the left of the implied or actual decimal point by a blank. 2. Replace the £ or £ character by a blank. 3. Replace the blank character to the left of the left-most digit by a £ or £.
+ or - present but £ £ and * all absent	1. Replace all leading zeros, if any, to the right of the + or - character up to, but not including, a zero to the left of the implied or actual decimal point by blank characters. 2. Replace the + or - character by a blank. 3. Replace the blank character to the left of the left-most digit by a + or - character.

18. IDENTIFICATION, VALIDATION AND GENERATION OF FIELD DESCRIPTIONS

18.1 BLANK FILLER

Table 18.1 Identification and validation of Blank FILLER field

Start of Field Identification	End of Field Identification	Field Validation
First character #	Last character followed by a non # character	Only # characters present.

The COBOL data description statement generated takes the following form:

02 FILLER PICTURE X(n) VALUE SPACES.

where n is the number of contiguous # characters in the field.

18.2 ALPHANUMERIC FILLER

Table 18.2 Identification and validation of Alphanumeric FILLER field

Start of Field Identification	End of Field Identification	Field Validation
First character "	Last character "	Both delimiting quotes (") must be present.

The COBOL data description statements generated take the following form:

02 FILLER PICTURE X(n) VALUE
"▽text-characters▽".

where

n is equal to two plus the number of characters between the

delimiting quotation marks in the line specification,

and

▽ is a space character to compensate for that occupied by a " character in the line specification.

If the number of characters in a text string is greater than 56, then statements for two FILLER items are generated as follows:

```
02 FILLER PICTURE X(57) VALUE
"▽first-fiftysix-text-characters".
02 FILLER PICTURE X(m) VALUE
"remaining-text-characters▽".
```

where m = n - 57 and n is as described above. Again ▽ denotes a compensating space character.

18.3 ALPHANUMERIC DATA ITEM

Table 18.3 Identification and validation of Alphanumeric data field

Start of Field Identification	End of Field Identification	Field Validation
First character a valid label character whose LABELTABLE record contains details of an alphanumeric item, i.e. Field type equals 'A'	Last character followed by one of the following: # + - £ $ * " Alphabetic characters other than the current label character	1. The label character must not previously have appeared in a field description in the current line. 2. B and 0 characters may be present, but only if they are somewhere to the right of a label character and not in the last character position of the field specification. 3. The resulting PICTURE string (Table 18.4) must not be more than 30 characters long.

The COBOL data description generated has the following form:

02 data-name PICTURE picture-string.

where

data-name is the second field of the LABELTABLE record for the label character used in the field format description,

and

picture-string is the value of a string variable whose contents is derived from the field format specification in the way indicated in Table 18.4.

Table 18.4 Derivation of a picture string from an alphanumeric field format specification.

Alphanumeric field specification character(s)	Corresponding picture-string character(s)
Label character	X
Five or more contiguous label characters	X(n) where n is the number of contiguous label characters.
B	B
Five or more contiguous B characters	B(n) where n is the number of contiguous B characters.
0	0

N.B. The resulting picture-string must not exceed 30 characters.

18.4 NUMERIC DATA ITEM

Table 18,5 Identification and validation of Numeric data field

Start of Field Identification	End of Field Identification	Field Validation
First character one of the following: + - £ ß * Valid label character whose LABELTABLE record contains details of a numeric item, i.e. Field type equals 'N'	Last two characters CR or DB or last character followed by one of the following: # + - £ ß * " Alphabetic character other than the current label character	1. At least one valid label character, whose LABELTABLE record contains details of a numeric item must be present. 2. The label character must not previously have appeared in a field description in the same line. 3. + or - may only appear as the first character of the field. 4. £ or ß may only appear once and may only be preceded by a + or -. 5. * may only appear once and may only be preceded by + - ß or £. 6. . may appear only once but not as the last character. It must be preceded by a label character. 7. If used, CR or DB may only appear as the last two characters of the field. They may not be used when a + or - is present in the field specification. 8. B , 0 characters may be present, but only if they are somewhere to the right of a label character and not in the last position of the field specification. 9. 30 characters is the maximum field specification size.

The COBOL data description statement generated takes the following form:

02 data-name PICTURE picture-string.

where

data-name is the second field of the LABELTABLE record for the label character in the field specification.

and

picture-string is the value of a string variable whose contents is derived from the field format specification in the way indicated in Tables 18.6 and 18.7.

Table 18.6 Derivation of a picture string from a numeric field format specification - Part 1

Numeric field specification character(s)	Corresponding picture-string character(s)
Label character	9
+	+
-	-
£ or $	£ or $
*	*
,	,
0	0
B	B
CR	CR
DB	DB

Table 18.7 Derivation of a picture string from a numeric field format specification - Part 2

Adjustments to the picture-string prior to the generation of the COBOL data description statement	
Conditions to be satisfied by the picture-string	Changes to be made to the picture-string
None of the following edit characters present: + - $ £ *	Replace each 9 character to the left of that in the units position, if any, by a Z (i.e. the COBOL zero suppression character).
* present	Replace each 9 character to the right of the * and to the left of that in the units position, if any, by an * (i.e. the COBOL floating cheque protect character).
£ or $ present but * absent	Replace each 9 character to the right of the £ or $ and to the left of the units position, if any, by a £ or $ (i.e. the COBOL floating currency character).
+ or - present but £ or $ or * absent	Replace each 9 character to the right of the + or - and to the left of the units position, if any, by a + or - (i.e. the COBOL floating sign character).

18.5 DATE ITEM

The date field is identified in the line format specification by the presence of the eight character string DD/MM/YY. It may only occur once in any line. The COBOL level 02 data description generated has the following form:

```
02 ZDATE PICTURE X(8).
```

18.6 TIME ITEM

The eight character string HH/MM/SS identifies the presence of the time field in the line format specification. It may occur only one in any line. The COBOL level 02 data description generated takes the form:

```
02 ZTIME PICTURE X(8).
```

18.7 PAGE NUMBER ITEM

The presence of the page number field in a line format specification is identified by the four character string PPPP. It may occur only once in any line. The COBOL level 02 statement generated has the following form:

```
02  Z-PAGE-COUNT PICTURE ZZZ9.
```

19. WRITEPARA MACRO

The general form of the statements generated during Stage 10 of the problem specifying dialogue for the WRITEPARA macro is as follows:

```
%DEF   WRITEPARA
%      LABELOFF
          IF Z-LINE-COUNT GREATER THAN Z-L-C(1) PERFORM Z-PARA-PAGE.
```

1st non-blank detail line.

```
          MOVE CORRESPONDING Z-TUPLE TO Z-DETAIL-1.
          ADD m TO Z-ADV-LINES.
          WRITE Z-OUTREC FROM Z-DETAIL-1 AFTER ADVANCING Z-ADV-LINES.
```

Subsequent non-blank detail lines if any.

```
          MOVE CORRESPONDING Z-TUPLE TO Z-DETAIL-n.
          WRITE Z-OUTREC FROM Z-DETAIL-n AFTER ADVANCING p LINES.
          .
          .
          .
          MOVE q TO Z-ADV-LINES.
          ADD r TO Z-LINE-COUNT.
          MOVE 0 TO Z-PAGE-SWITCH.
%      LABELON
%END
```

where:

l equals the number of key domains, i.e. the value in global variable #GNKEY.

m equals one plus the number of blank lines before the first non-blank detail line of the print group.

n equals the non-blank detail line number. n takes the values 2, 3, 4, etc depending on the number of non-blank lines in the print group.

p equals one plus the number of blank lines before the current non-blank line of the print group.

r equals the total number of lines, including blank lines, in the detail print group.

20. TITLEPARA MACRO

The general form of the TITLEPARA macro, the statements for which are generated during Stage 12 of the problem specifying dialogue, is as follows:

```
%DEF   TITLEPARA
%      LABELOFF
        Z-PARA-TITLE.
            MOVE SPACES TO Z-OUTREC.
            WRITE Z-OUTREC BEFORE ADVANCING CHANNEL-1.

1st non-blank title line.   MOVE CORRESPONDING Z-TUPLE TO Z-TITLE-1.
                            WRITE Z-OUTREC FROM Z-TITLE-1 AFTER ADVANCING 1 LINES.

Subsequent non-blank title lines if any.   MOVE CORRESPONDING Z-TUPLE TO Z-TITLE-n.
                                           WRITE Z-OUTREC FROM Z-TITLE-n AFTER ADVANCING m LINES.
                                                  :
                                                  :
                                                  :
%      LABELON
%END
```

where:

n equals the number of the non-blank line. n takes the values 2, 3, etc depending on the number of non-blank lines in the print group.

1 equals the number of blank lines before the first non-blank title line.

m equals one plus the number of blank lines before the current non-blank title line.

The MOVE CORRESPONDING statement before each WRITE operation is generated only if the date, time or page number appears in the line format specification.

21. PHEADPARA MACRO

The general form of the statements generated during Stage 13 of the problem specifying dialogue for the PHEADPARA macro is as follows:

```
%DEF   PHEADPARA
%      LABELOFF
```

1st non-blank line of page heading.
```
       MOVE CORRESPONDING Z-TUPLE TO Z-PAGE-1.
       WRITE Z-OUTREC FROM Z-PAGE-1 AFTER ADVANCING 1 LINES.
```

Subsequent non-blank page heading lines, if any.
```
       MOVE CORRESPONDING Z-TUPLE TO Z-PAGE-n.
       WRITE Z-OUTREC FROM Z-PAGE-n AFTER ADVANCING m LINES.
       :
       :
```

Page control statements
```
       MOVE q TO Z-ADV-LINES.
       MOVE r TO Z-LINE-COUNT.
       MOVE 1 TO Z-PAGE-SWITCH
%      LABELON
%END
```

where:

l — equals the number of blank lines before the first non-blank page heading line.

m — equals one plus the number of blank lines before the current non-blank page heading line.

n — equals the number of the non-blank page heading line, i.e. n takes the values 2, 3, etc depending on the number of non-blank lines in the page heading.

q — equals the number of blank lines after the final non-blank page heading line.

r — equals the total number of lines, including blank lines, in the page heading print group.

The MOVE CORRESPONDING statement before each WRITE operation is generated only if the date, time, page number or a label character appears in the line format specification. If the user does not wish to specify a printed page heading, only the page control statements are generated in the body of the macro. In this case both q and r have the value zero.

22. SBHPARAn MACROS

The general form of the statements generated during Stage 14 for the SBHPARAn macros is as follows:

```
%DEF   SBHPARAn
%      LABELOFF
1st non-blank line of the sequence break heading
       ADD 1 TO Z-ADV-LINES
       MOVE CORRESPONDING Z-TUPLE TO Z-HEADn-1.
       WRITE Z-OUTREC FROM Z-HEADn-1 AFTER ADVANCING Z-ADV-LINES.
Subsequent non-blank lines, if any.
       MOVE CORRESPONDING Z-TUPLE TO Z-HEADn-m.
       WRITE Z-OUTREC FROM Z-HEADn-m AFTER ADVANCING p LINES.
          :
          :
          :
       MOVE q TO Z-ADV-LINES.
       ADD r TO Z-LINE-COUNT.
%      LABELON
%END
```

where:

l equals one plus the number of blank lines before the first non-blank line of the sequence break heading.

m equals the number of the non-blank line in the sequence break heading, i.e. m takes the values 2, 3, etc depending on the number of non-blank lines in the print group.

n equals the level number of the sequence key, i.e. n takes the values 1, 2, 3, etc depending on the number of keys. There is a sequence break heading for each key except the minor key and 1 denotes the major key.

p equals one plus the number of blank lines before the current non-blank line of the sequence break heading.

q equals the number of blank lines after the final non-blank line in the sequence break heading.

r equals the total number of lines, including blank lines, in the current sequence break heading.

The MOVE CORRESPONDING statement is generated only if a label character appears in the format specification of the line.

23. STLPARAn MACROS

The STLPARAn macros generated during Stage 15 have the following general form:

```
%DEF   STLPARAn
%      LABELON
       ADD 1 TO Z-ADV-LINES.
       MOVE CORRESPONDING Z-LEVEL-n TO Z-SUBTOTALn-1.
       MOVE data-name IN Z-TUPLE TO data-name IN
       Z-SUBTOTALn-1.
       .
       .
       .
       WRITE Z-OUTREC FROM Z-SUBTOTALn-1 AFTER Z-ADV-LINES.

       MOVE CORRESPONDING Z-LEVEL-n TO Z-SUBTOTALn-m.
       MOVE data-name IN Z-TUPLE TO data-name IN
       Z-SUBTOTALn-m.
       .
       .
       .
       WRITE Z-OUTREC FROM Z-SUBTOTALn-m AFTER ADVANCING p LINES.

         MOVE q TO Z-ADV-LINES.
         ADD r TO Z-LINE-COUNT.
%      LABELON
%END
```

1st non-blank line of sequence break subtotal.

Subsequent non-blank lines, if any.

where:

l equals one plus the number of blank lines before the first non-blank line of the sequence break subtotal.

m equals the number of the non-blank line in the print group, i.e. m takes the values 2, 3, etc depending on the number of non-blank lines in the subtotal output.

n equals the level number of the sequence key, i.e. n takes the values 1, 2, 3, etc depending on the number of keys. There is a sequence break subtotal for each key level except the minor key and 1 denotes the major key.

p equals one plus the number of blank lines before the current non-blank line in the sequence break subtotal.

q equals the number of blank lines after the final non-blank line of the print group.

r equals the totals number of lines, including blank lines, in the current sequence break subtotal.

data-name equals the name of a non-totalling item which appears in the current line of the subtotal print group.

The MOVE CORRESPONDING statement is generated only if a label character for a totalling item appears in the format specification of the line. If only non-totalling data items are present in the line format specification, the MOVE CORRESPONDING Z-LEVEL-n statement is omitted and a MOVE CORRESPONDING Z-TUPLE statement may be used to replace the individual MOVE statements.

24. TOTALPARA MACRO

The general form of the statements generated for the TOTLPARA macro in Stage 16 is as follows:

```
%DEF  TOTLPARA
%     LABELOFF
1st non-blank totals line.
      ADD 1 TO Z-ADV-LINES.
      MOVE CORRESPONDING Z-LEVEL-0 TO Z-TOTAL-1.
      MOVE data-name IN Z-TUPLE TO data-name IN
      Z-TOTAL-1.
      :
      :
      WRITE Z-OUTREC FROM Z-TOTAL-1 AFTER ADVANCING Z-ADV-LINES.

Subsequent non-blank totals lines, if any.
      MOVE CORRESPONDING Z-LEVEL-0 TO Z-TOTAL-m.
      MOVE data-name IN Z-TUPLE TO data-name IN
      Z-TOTAL-m.
      :
      :
      WRITE Z-OUTREC FROM Z-TOTAL-m AFTER ADVANCING p LINES.
%     LABELON
%END
```

where:

l equals the number of blank lines before the first non-blank line of the totals print group.

m equals the number of the non-blank lines in the totals print group, i.e. m takes the values 2, 3, etc depending on the number of non-blank lines in the totals output.

p equals one plus the number of blank lines before the current non-blank line in the totals output.

data-name equals the name of a non-totalling item which appears in

in the current non-blank line of the totals print group. The MOVE CORRESPONDING Z-LEVEL-0 statement is generated only if a label character for a totalling item appears in the format specification of the line. A MOVE data-name IN Z-TUPLE statement is generated for each non-totalling item whose label character appears in the format specification of the line. If only non-totalling data items are present in a total line format specification, the MOVE CORRESPONDING Z-LEVEL-0 statement is not generated. A MOVE CORRESPONDING Z-TUPLE statement may then be used to replace the individual MOVE statements, if any.

25. COMBINATIONS OF REPORT OUTPUT CATEGORIES AND ASSOCIATED PAGE SIZE CONDITIONS

The combinations of report output categories and associated page size conditions are summarised in Table 25.1.

Table 25.1 Page size conditions

Page Type	Categories of output which may be included	Global variable used to indicate output category present	Name of subfile containing line count details	Symbol used for line count value	Conditions to be satisfied
Title page	Report title	#GTITL	PAGETITLE	Lr	$Lr \leq$ #GMXLN
Report page	Page heading	#GPAGE	PAGEHEAD	Lp	$L+Ld \leq$ #GMXLN where $L=Lp+\sum_{i=1}^{m} Lsh_i$
	Sequence break heading	#GHEAD	PAGESBHn where n=1 to m and m=#GNKEY -1	Lsh_i	
	Detail line(s)	Always present	PAGEDETAIL	Ld	
	Page heading	#GPAGE	PAGEHEAD	Lp	$L+Lst_j \leq$ #GMXLN for j=1 to m where $L=Lp+\sum_{i=1}^{m} Lsh_i$
	Sequence break heading	#GHEAD	PAGESBHn where n=1 to m and m=#GNKEY -1	Lsh_i	
	Sequence break subtotal	#GSUBT	PAGESTLj where j indicates the key level	Lst_j	

N.B. Global variable #GMXLN contains the maximum number of lines permitted on a page.

Table 25.1 continued

Page Type	Categories of output which may be included	Global variable used to indicate output category present	Name of subfile containing line count details	Symbol used for line count value	Conditions to be satisfied
Report page	Page heading	#GPAGE	PAGEHEAD	Lp	L+Lt ≤ #GMXLN where $L=Lp+\sum_{i=1}^{m} Lsh_i$
	Sequence break heading	#GHEAD	PAGESBHn where n=1 to m and m=#GNKEY -1	Lsh_i	
	Totals	#GTOTL	PAGETOTL	Lt	

N.B. Global variable #GMXLN contains the maximum number of lines permitted on a page.

26. OWNname MACROS

The general form of the OWNname macros is as follows:

```
%DEF   OWNname
%      LABELOFF
       conditional-expression-1
       imperative-statement-1.
       conditional-statement-2
       imperative-statement-2.
       ;
       ;
       ;
%      LABELON
%END
```

where:

name is the processing point in the COBOL program where the own code has to be executed (See Table 26.1 of this appendix for details).

conditional-expression represents lines of COBOL generated from the user entered condition specification which may be simple or compound. Condition specification is optional.

imperative-statement represents the COBOL statement generated from the user's own code statement (Section 27 of this appendix).

Table 26.1 Macro definition subfile names used for own code processing

Subfile name	COBOL program processing point
OWNSTART	At the start of processing before any data is retrieved.
OWNRETR	Immediately after a data retrieval.
OWNTITL	Prior to printing the report title.
OWNSBK1 OWNSBK2 OWNSBK3 OWNSBK4 OWNSBK5 OWNSBK6 OWNSBK7 OWNSBK8	At a sequence break in the key domain whose level is indicated by the digit at the end of the subfile name. Level 1 is for the major key. N.B. In any problem only up to m subfiles will be used where m = #GNKEY-1
OWNPAGE	Prior to printing a page heading.
OWNSBH1 OWNSBH2 OWNSBH3 OWNSBH4 OWNSBH5 OWNSBH6 OWNSBH7 OWNSBH8	Prior to printing the sequence break heading for the key domain whose level is indicated by the digit at the end of the subfile name. Level 1 is for the major key. N.B. In any problem only up to m subfiles will be used where m = #GNKEY-1
OWNDETAIL	Prior to printing the detail line(s).
OWNSTL1 OWNSTL2 OWNSTL3 OWNSTL4 OWNSTL5 OWNSTL6 OWNSTL7 OWNSTL8	Prior to printing the sequence break subtotals for the sequence key whose level is indicated by the digit at the end of the subfile name. The major key is at level 1. N.B. In any problem only up to m subfiles will be used where m = #GNKEY-1
OWNTOTL	Prior to printing the total line(s).

27. OWN CODE STATEMENTS

This section describes the identification and validation of the user's own code statements from which equivalent COBOL statements are generated. The own code statements are described in the following order:

1. ADD
2. SUBTRACT
3. MULTIPLY
4. DIVIDE
5. MOVE

27.1 ADD OWN CODE STATEMENT

ADD operand-1, operand-2 GIVING operand-3

Table 27.1 Identification of the ADD statement and delimiters of operands

Item	Comments
ADD	Must be the first non-blank substring of the user's response.
operand-1	Starts with the first non-blank character after the final D of ADD. Delimited by a blank or comma character.
,	Must be present after the first operand but may be preceded by one or more blanks.
operand-2	Starts with the first non-blank character after the comma. Delimited by a blank character or by the first G of GIVING.
GIVING	Must be present after the second operand but may be preceded by one or more blank characters.
operand-3	Starts with the first non-blank character after the final G of GIVING. Delimited by a blank character or the end of the response string.

Table 27.2 Permitted operand types for ADD, SUBTRACT and MULTIPLY

Operand	Type		
	Numeric literal (Note 1)	Domain or Temporary item name (Note 2)	Domain or Temporary item name prefaced by * (Note 3)
operand-1	✓	✓	✓
operand-2	✓	✓	✓
operand-3	×	✓	×

Notes

1. The rules for a valid numeric literal are given in Table 12.1 of this appendix.
2. The domain or temporary item name must have a matching record in the DOMAININDEX subfile with Field type equal to 'N' (Appendix V Section 7).
3. The domain or temporary item name must have a matching record in the DOMAININDEX subfile with the Totalling marker equal to 'T' or 'S'.

Three lines of COBOL are generated for each ADD own code statement and they take the following form:

```
ADD operand-1-replacement,
operand-2-replacement GIVING
operand-3-replacement.
```

where the operand replacement details are given in Table 27.3.

Table 27.3 Operand replacement details for Arithmetic operations

Own code operand type	COBOL replacement
Numeric literal	Numeric literal
Domain or Temporary item name	item-name IN Z-TUPLE where item-name is that specified in the user's own code statement.
Domain or Temporary item name prefaced by *	item-name IN Z-LEVEL-n where item-name is that specified in the user's own code statement and n is the level number of the current sequence break key.

27.2 SUBTRACT OWN CODE STATEMENT

SUBTRACT operand-1 FROM operand-2 GIVING operand-3

Table 27.4 gives details of the identification of the SUBTRACT statement and the delimiters of the operands. The operand types permitted are shown in Table 27.2.

Three lines of COBOL are generated for each SUBTRACT own code statement and they take the following form:

```
SUBTRACT operand-1-replacement FROM
operand-2-replacement GIVING
operand-3-replacement.
```

The operand replacement details are given in Table 27.3.

Table 27.4 Identification of the SUBTRACT statement and delimiters of operands

Item	Comments
SUBTRACT	Must be the first non-blank substring of the user's response.
operand-1	Starts with the first non-blank character after the final T of SUBTRACT. Delimited by a blank character or the F of FROM.
FROM	Must be present after the first operand but may be preceded by one or more blank characters.
operand-2	Starts with the first non-blank character after the M of FROM. Delimited by a blank character or the first G of GIVING.
GIVING	Must be present after the second operand but may be preceded by one or more blanks.
operand-3	Starts with the first non-blank character after the final G of GIVING. Delimited by a blank character or the end of the response string.

27.3 MULTIPLY OWN CODE STATEMENT

MULTIPLY operand-1 BY operand-2 GIVING operand-3

Table 27.5 gives details of the identification of the MULTIPLY statement and the delimiters of the operands. The operand types permitted are shown in Table 27.2.

Three lines of COBOL are generated for each MULTIPLY own code statement and they take the following form:

```
MULTIPLY operand-1-replacement BY
operand-2-replacement GIVING
operand-3-replacement.
```

The operand replacement details are given in Table 27.3.

Table 27.5 Identification of the MULTIPLY statement and delimiters of operands

Item	Comments
MULTIPLY	Must be the first non-blank substring of the user's response.
operand-1	Starts with the first non-blank character after the Y of MULTIPLY. Delimited by a blank character or the B of BY.
BY	Must be present after the first operand but may be preceded by one or more blank characters.
operand-2	Starts with the first non-blank character after the Y of BY. Delimited by a blank character or the first G of GIVING.
GIVING	Must be present after the second operand but may be preceded by one or more blank characters.
operand-3	Starts with the first non-blank character after the final G of GIVING. Delimited by a blank character or the end of the response string.

27.4 DIVIDE OWN CODE STATEMENT

DIVIDE operand-1 BY operand-2 GIVING operand-3

The remainder, if retained by the user, is operand-4.

Table 27.6 Identification of the DIVIDE statement and delimiters of operands

Item	Comments
DIVIDE	Must be the first non-blank substring of the user's response.
operand-1	Starts with the first non-blank character after the E of DIVIDE. Delimited by a blank character or the B of BY.
BY	Must be present after the first operand but may be preceded by one or more blank characters.
operand-2	Starts with the first non-blank character after the Y of BY. Delimited by a blank character or the first G of GIVING.
GIVING	Must be present after the second operand but may be preceded by one or more blank characters.
operand-3	Starts with the first non-blank character after the final G of GIVING. Delimited by a blank character or the end of the response string.
operand-4	This exists only if the user enters a non-blank response when invited to save the remainder.

Table 27.7 Permitted operand types for DIVIDE

Operand	Type		
	Numeric literal (Note 1)	Domain or Temporary item name (Note 2)	Domain or Temporary item name prefaced by * (Note 3)
operand-1	✓	✓	✓
operand-2	✓	✓	✓
operand-3	×	✓	×
operand-4 (optional)	×	✓	×

Notes

1. The rules for a valid numeric literal are given in Table 12.1 of this appendix.
2. The domain or temporary item name must have a matching record in the DOMAININDEX subfile with Field type equal to 'N' (Appendix V Section 7).
3. The domain or temporary item name must have a matching record in the DOMAININDEX subfile with the Totalling marker equal to 'T' or 'S'.

Four or three lines of COBOL are generated for each DIVIDE own code statement entered by the user. Four lines are generated if the user opts to retain the remainder, i.e. operand-4 is specified, otherwise the three line version is generated. These statements have the following forms:

```
DIVIDE operand-1-replacement BY
operand-2-replacement GIVING
operand-3-replacement
REMAINDER operand-4-replacement.
```

or

```
DIVIDE operand-1-replacement BY
operand-2-replacement GIVING
operand-3 replacement.
```

27.5 MOVE OWN CODE STATEMENT

MOVE operand-1 TO operand-2

Table 27.8 Identification of the MOVE statement and delimiters of operands

Item	Comments
MOVE	Must be the first non-blank substring of the user's response.
operand-1	Starts with the first non-blank character after the E of MOVE. Delimited by a blank character or the T of TO.
TO	Must be present after the first operand but may be preceded by one or more blank characters.
operand-2	Starts with the first non-blank character after the O of TO. Delimited by a blank character or the end of the response string.

Table 27.9 Permitted operand types for MOVE

Operand	Type		
	Numeric literal (Note 1)	Alphanumeric literal (Note 2)	Domain or Temporary item name (Note 3)
operand-1 (Note 4)	✓	✓	✓
operand-2	×	×	✓

Notes

1. The rules for a valid numeric literal are given in Table 12.1 of this appendix.
2. An alphanumeric literal is delimited by double quotation mark characters (").
3. The domain or temporary item name must have a matching

record in the DOMAININDEX subfile (Appendix V Section 7).

4. Operand-1 must be of the same type, i.e. numeric or alphanumeric, as operand-2. When an operand is a domain or temporary item its type is indicated in its DOMAININDEX subfile record.

Two lines of COBOL are generated for each MOVE own code statement entered by the user and they take the following form:

```
MOVE operand-1-replacement
TO operand-2-replacement.
```

where the operand replacement details are given in Table 27.10.

Table 27.10 Operand replacement details for MOVE operations

Own code operand type	COBOL replacement
Numeric literal	Numeric literal
Alphanumeric literal	Alphanumeric literal
Domain or Temporary item name	item-name IN Z-TUPLE where item-name is that specified in the user's own code statement.

28. CONSTANTS MACRO

The statements generated for the CONSTANTS macro have the following form:

```
%DEF   CONSTANTS
%      RESET #S05                      Only present if global variable
%      DEPOSIT5 ..........$            #GMOP is equal to 'Y'.

%      #GNREL = ...
%      #GNKEY = ...                    Entries for all the global
%      #GTOT = ...                     variables shown in Table 28.1
       :
       :
       :
%END
```

Table 28.1 String and global variables in the CONSTANTS macro

Variable name	Stage in which first used	Type of data C=character B=binary	Comments
#S05	6	C	Message for file mismatch condition. Only present if #GMOP is equal to 'Y'.
#GNREL	2	B	No. of relations (files) used.
#GNKEY	3	B	No. of sequence keys.
#GTOT	4	B	Totalling indicator 1 = totals required 0 = no totals required
#GDMCT	5	B	No. of domains in DOMAININDEX subfile.
#GMOP	6	C	Message option indicator Y = message required N or blank = no message
#GWDTH	8	C	Page width indicator N = narrow page W = wide page
#GMXLN	8	B	Maximum no. of lines on a page.
#GTITL	12	B	1 = Title page present 0 = Title page absent

Table 28.1 continued

Variable name	Stage in which first used	Type of data C=character B=binary	Comments
#GPAGE	13	B	1 = Page heading present 0 = Page heading absent
#GHEAD	14	B	1 = Sequence break headings present 0 = Sequence break headings absent
#GSUBT	15	B	1 = Sequence break subtotals present 0 = Sequence break subtotals absent
#GTOTL	16	B	1 = Totals output required 0 = Totals output not required

29. HELP MACRO

The processing within the HELP macro consists of the steps outlined below. The first statement of each step has been highlighted on the macro listing (Item 28 in the separate folder).

1. Clean up the output stack by emptying any statements it may contain onto the WORK subfile which acts as a 'sink' (c.f Section 7.17 of main text).

2. Test the value of the check point global variable #GCKPT to see how many options should be offered to the user. Options 1 to 3 are always offered, but option 4 (trial editing) is offered only after Stage 9 of the problem specifying dialogue has been reached.

3. Output on the user's terminal the text from the DIALHELP subfile which lists the options available.

4. Invite the user to select an option.

5. Read and validate the user's response. This must be an integer in the range 1 to 3 if #GCKPT was less than 9, otherwise it may be in the range 1 to 4. The default reponse option is 1. If the response is invalid an error message is output on the user's terminal and the step is repeated.

6. Depending on the option value, processing continues at step 7, 8, 13 or 15.

7. Option 1. The 'Run abandoned' message is output on the user's terminal together with an instruction to type a %FINISH response. The %FINISH response effects an exit from the PG/2 macro processor system.

8. Option 2. A list of the stages at which the user may restart processing is output on his terminal from the DIALHELP text subfile. The value of the #GCKPT check point variable is used to determine the text lines printed and consequently the stages included in the option list.

9. Invite the user to enter the number of the stage at which he wishes to resume processing.

10. Read and validate the user's response. The response must consist of 1 or 2 digit characters which, when converted to binary, have a value in the range 1 to #GCKPT. If the response is invalid an error message is output on the user's terminal and the step is repeated. The restart stage number is stored in local variable #LV1.

11. The check point global variable #GCKPT is set equal to 1 less than the restart stage number. This ensures that the restart stage macro is entered normally, i.e. it appears to have been entered from the previous stage.

12. Chain to the macro for the selected restart stage. When this macro is not on the same mainfile as the HELP macro it is necessary to execute a MAINFILE macro-time statement to set

the appropriate mainfile prior to chaining to the selected macro.

13. Option 3. The text from the MODEL subfile with the suffix value equal to #GCKPT is output on the user's terminal. If #GCKPT is equal to 17 (Sample page stage) then a special routine is used for outputting the text. This routine contains macro-time statements which replace the greater than (>) character at the beginning of any text record by a blank character prior to its output on the user's terminal. These greater than characters were inserted in otherwise blank records to overcome the difficulty of reading all blank records with the FREAD macro-time statement (Section 9.2 of Appendix V).

14. Set the restart stage number stored in local variable #LV1 equal to #GCKPT and continue processing at step 11 above.

15. Option 4. Chain to the STAGE9 macro which carries out the dialogue for experimenting with the edit facilities.

30. SUMMARY OF SUBFILE USAGE AND INITIALISATION

Table 30.1 summarises the names and types of subfile used by the COBOL report program generating system and shows their arrangement on PG/2 macro processor mainfiles.

A WORK subfile is included in each mainfile where it is used as the output subfile when macro and text subfiles are edited during development (Appendix I Section1). The WORK subfile containing the amended macro definition or text is then copied back into the original subfile. The WORK subfile is also available for use as a 'sink' by the HELP and report format specification macros.

Some of the common data and 'grown' macro definition subfiles require initialisation prior to the execution of the first stage of the problem specifying dialogue. The initialisation is achieved by using a preset input file containing the necessary

PG/2 macro processor commands which also contains the commands which load and call the STAGE1 macro. Further input is obtained from the user's terminal in response to the dialogue prompts. Details of the subfiles which require initialisation are given in Tables 30.2 and 30.3.

Table 30.1 Subfile organisation

Mainfile name	GWAC132-DATA		GWAC132-DAT1		GWAC132-DAT2		GWAC132-DAT3	
	Subfile	Type	Subfile	Type	Subfile	Type	Subfile	Type
1	CREATE	M	CONCAT	M	STAGE14	M	STAGE15	M
2	MESSAGES	T	TEMPITEM	M	DIAL14	T	DIAL15	T
3	PASSCHANGE	M	STAGE6	M	SBHREC1	M	STLREC1	M
4	LIBRARIAN	M	DIAL6	T	SBHREC2	M	STLREC2	M
5	LIBPRELIM	M	STAGE7	M	SBHREC3	M	STLREC2	M
6	LIBADD	M	DIAL7	T	SBHREC4	M	STLREC4	M
7	LIBDELETE	M	SELCOND	M	SBHREC5	M	STLREC5	M
8	CATALOGUE	C	STAGE8	M	SBHREC6	M	STLREC6	M
9	STAGE1	M	DIAL8	T	SBHREC7	M	STLREC7	M
10	DIAL1	T	LABELTABLE	C	SBHREC8	M	STLREC8	M
11	STAGE2	M	STAGE9	M	SBHPARA1	M	STLPARA1	M
12	DIAL2	T	DIAL9	T	SBHPARA2	M	STLPARA2	M
13	RELATIONDICT	C	STAGE10	M	SBHPARA3	M	STLPARA3	M
14	STAGE3	M	DIAL10	T	SBHPARA4	M	STLPARA4	M
15	DIAL3	T	DETAILREC	M	SBHPARA5	M	STLPARA5	M
16	DOMAINDICT	C	WRITEPARA	M	SBHPARA6	M	STLPARA6	M
17	KEYDICT	C	PAGEDETAIL	C	SBHPARA7	M	STLPARA7	M
18	SUBMODEL	C	STAGE11	M	SBHPARA8	M	STLPARA8	M
19	STAGE3-1	M	DIAL11	T	PAGESBH1	C	PAGESTL1	C
20	STAGE4	M	STAGE12	M	PAGESBH2	C	PAGEST12	C
21	DIAL4	T	DIAL12	T	PAGESBH3	C	PAGESTL3	C
22	DOMAINLIST	C	TITLEREC	M	PAGESBH4	C	PAGESTL4	C
23	STAGE5	M	TITLEPARA	M	PAGESBH5	C	PAGESTL5	C
24	DIAL5	T	PAGETITLE	C	PAGESBH6	C	PAGESTL6	C
25	DOMAININDEX	C	STAGE13	M	PAGESBH7	C	PAGESTL7	C
26	STAGE5-1	M	DIAL13	T	PAGESBH8	C	PAGESTL8	C
27	STAGE5-2	M	PHEADREC	M	WORK	S	WORK	S
28	HELP	M	PHEADPARA	M				
29	DIALHELP	T	PAGEHEAD	C				
30	WORK	S	WORK	S				

C = Common data, M = Macro definition, T = Text, S = 'Sink'

Table 30.1 continued

Mainfile name	GWAC132-DAT4		GWAC132-DAT5		GWAC132-MODL	
	Subfile	Type	Subfile	Type	Subfile	Type
1	STAGE16	M	OWNRETR	M	MODEL1	T
2	DIAL16	T	OWNTITL	M	MODEL2	T
3	TOTLREC	M	OWNSBK1	M	MODEL3	T
4	TOTLPARA	M	OWNSBK2	M	MODEL4	T
5	PAGETOTL	C	OWNSBK3	M	MODEL5	T
6	STAGE17	M	OWNSBK4	M	MODEL6	T
7	DIAL17	T	OWNSBK5	M	MODEL7	T
8	STAGE17-1	M	OWNSBK6	M	MODEL8	T
9	STAGE17-2	M	OWNSBK7	M	MODEL9	T
10	STAGE17-3	M	OWNSBK8	M	MODEL10	T
11	STAGE17-4	M	OWNPAGE	M	MODEL11	T
12	STAGE17-5	M	OWNSBH1	M	MODEL12	T
13	STAGE18	M	OWNSBH2	M	MODEL13	T
14	DIAL8	T	OWNSBH3	M	MODEL14	T
15	COMMENTS	T	OWNSBH4	M	MODEL15	T
16	CONSTANTS	T	OWNSBH5	M	MODEL16	T
17	COBOLPROG	T	OWNSBH6	M	MODEL17	T
18	TUPLE	M	OWNSBH7	M	MODEL18	T
19	PICTUREDICT	C	OWNSBH8	M	WORK	S
20	OWNSTART	M	OWNSTL1	M		
21	WORK	S	OWNSTL2	M		
22			OWNSTL3	M		
23			OWNSTL4	M		
24			OWNSTL5	M		
25			OWNSTL6	M		
26			OWNSTL7	M		
27			OWNSTL8	M		
28			OWNTOTL	M		
29			OWNDETAIL	M		
30			WORK	S		

C = Common data, M = Macro definition, T = Text, S = 'Sink'

Table 30.2 Initialisation of 'grown' macro definition subfiles

'Grown' macros requiring initialisation			Initial contents
TITLEPARA	STLPARA4	OWNSBK6	Empty macro definition consisting of the following two statements: %DEF macro-name %END where macro-name is the name of the subfile.
TITLEREC	STLPARA5	OWNSBK7	
PHEADPARA	STLPARA6	OWNSBK8	
PHEADREC	STLPARA7	OWNPAGE	
SBHPARA1	STLPARA8	OWNSBH1	
SBHPARA2	STLREC1	OWNSBH2	
SBHPARA3	STLREC2	OWNSBH3	
SBHPARA4	STLREC3	OWNSBH4	
SBHPARA5	STLREC4	OWNSBH5	
SBHPARA6	STLREC5	OWNSBH6	
SBHPARA7	STLREC6	OWNSBH7	
SBHPARA8	STLREC7	OWNSBH8	
SBHREC1	STLREC8	OWNDETAIL	
SBHREC2	TOTLPARA	OWNSTL1	
SBHREC3	TOTLREC	OWNSTL2	
SBHREC4	OWNSTART	OWNSTL3	
SBHREC5	OWNRETR	OWNSTL4	
SBHREC6	OWNTITL	OWNSTL5	
SBHREC7	OWNSBK1	OWNSTL6	
SBHREC8	OWNSBK2	OWNSTL7	
STLPARA1	OWNSBK3	OWNSTL8	
STLPARA2	OWNSBK4	OWNTOTL	
STLPARA3	OWNSBK5		

Table 30.3 Initialisation of common data subfiles

Common data subfile name	Stage first used	Initial contents
RELATIONDICT	2	All subfiles have one record which contains a zero character.
DOMAINDICT	3	
SUBMODEL	3	
DOMAINLIST	4	
DOMAININDEX	5	
PAGEDETAIL	10	
PAGETITLE	12	
PAGEHEAD	13	
PAGESBH1	14	
PAGESBH2	14	
PAGESBH3	14	
PAGESBH4	14	
PAGESBH5	14	
PAGESBH6	14	
PAGESBH7	14	
PAGESBH8	14	
PAGESTL1	15	
PAGESTL2	15	
PAGESTL3	15	
PAGESTL4	15	
PAGESTL5	15	
PAGESTL6	15	
PAGESTL7	15	
PAGESTL8	15	
PAGETOTL	16	

APPENDIX VIII

COBOL REPORT PROGRAM GENERATION DETAILS

ILLUSTRATIONS

APPENDIX VIII

COBOL REPORT PROGRAM GENERATION DETAILS

The text in this appendix describes the generation of a COBOL report program in the general case where the data is on more than one input file and is sequenced on more than one key. The description is presented in program listing order:

1. Steering lines
2. Identification division
3. Environment division
4. Data division preliminaries
5. File section
6. Working-storage section level 77 entries
7. Group description entries
8. Procedure division entries
9. Z-INITIAL section, paragraph Z-PARA-1
10. Paragraph Z-PARA-2
11. Z-INITIAL section, paragraph Z-PARA-3
12. Paragraph Z-PARA-4
13. Paragraph Z-PARA-5
14. Z-FINAL section, paragraph Z-PARA-FINAL
15. Paragraph Z-CLOSE-DOWN
16. Z-OTHER-PROCEDURES section
17. Paragraph Z-PARA-ADD
18. Paragraph Z-PARA-WRITE
19. Paragraphs Z-END-PAGE-COUNTS and Z-START-LINE
20. Paragraphs Z-HEADi and Z-HEADi-EXIT
21. Paragraphs Z-TOTALi
22. Paragraph Z-PARA-TITLE
23. Paragraph Z-PARA-PAGE
24. Paragraph Z-HEADi-WRITE
25. Paragraphs Z-TOTALi-WRITE

1. STEERING LINES

The Stering lines are input parameters for the COBOL compiler which specify the options required. They are independent of the user's program statements and form a separate input file. For the installation where the practical work was developed it was appropriate to generate the following statements:

```
*IDENTITY COBL
*COMPILE
*COBOL CARDS (GENPROG)
*OBJECT EDS (ICLA-DEFAULT)
*STANDARD
*CONSOLIDATE EDS XPCK
*SUBGROUPS EDS (SUBGROUPS-RS)
*LOAD
*LIST S P
****
```

The above code is easily varied to suit other circumstances.

2. IDENTIFICATION DIVISION

The following statements are generated for this division:

```
IDENTIFICATION DIVISION.
PROGRAM-ID. COBLO1.
DATE-WRITTEN. today's-date.
```

where today's-date is the value in system global variable #GCDT which is set by the DATE macro-time statement.

3. ENVIRONMENT DIVISION

The general form of the statements generated for this division is as follows:

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. ICL-1907.
OBJECT-COMPUTER. ICL-1907 MEMORY SIZE 19000 WORDS.
SPECIAL-NAMES.
    PRINTER IS TEST-PRINTER
    *DATE IS Z-DATE *TIME IS Z-TIME.
INPUT-OUTPUT SECTION.
FILE-CONTROL. SELECT Z-REPORT-FILE ASSIGN TO PRINTER 1.
    SELECT Z-FILE-1 ASSIGN TO hardware-name integer.
           :          :          :          :
    SELECT Z-FILE-n ASSIGN TO hardware-name integer.
```

The source and object computer statements are tailored to the installation where the practical work was developed. The memory size was set to be the maximum permitted for running programs on-line; larger programs had to be run in batch mode. The above code is easily varied to suit a different environment.

In the SPECIAL-NAMES paragraph the test-printer statement is only generated if the user opted to have a message displayed when a mis-match file condition is detected, i.e. global variable #GMOP is equal to 'Y' (Appendix VII Section 14). The *DATE and *TIME statements are a necessary preliminary which enables Procedure division statements to access the date and time values in the operating system executive at program execution time.

The input files are those described in the SUBMODEL subfile (Section 7.10 of main text) and, for the purpose of program generation, are named in the order in which they occur as Z-FILE-1, Z-FILE-2, etc up to Z-FILE-n, where n is the value in global variable #GNREL. The hardware-name for each file is derived from the File medium field in each Type 3 File name record in the SUBMODEL subfile. The following shows the derivation:

SUBMODEL File medium	COBOL Hardware-name
CR	CARD-READER
ED	EDS
MT	TAPES
PT	PAPER-READER

The integer value is associated with the hardware-name. It starts with 1 and is incremented by 1 for each file with the same hardware-name.

4. DATA DIVISION PRELIMINARIES

The name of each input data item occurs in at least three group items within the Data division: the record description in the File section and the TUPLE and TUPLE-N groups in the Working-

storage section. Although in the case of numeric data items the USAGE clause will differ, the PICTURE clause will be the same. It is therefore convenient to record in the PICTUREDICT subfile a dictionary of data item names and their corresponding PICTURE. The format of the PICTUREDICT subfile is described in tabular form in Section 10 of Appendix V.

The data from which the PICTURE is derived, i.e. length, type and decimal point location, is located in the fields of the DOMAININDEX subfile records (Appendix V Section 7). The DOMAININDEX subfile is read record by record, the required data extracted and the PICTURE string generated. The corresponding PICTUREDICT subfile record may then be inserted. DOMAININDEX contains details of user created temporary items as well as those from the input files. For the temporary data items empty picture strings are inserted in the corresponding PICTUREDICT subfile record. This ensures a one to one correspondence between the records of the DOMAININDEX and PICTUREDICT subfiles.

During the pass through the records of the DOMAININDEX subfile, the statements for the TUPLE and SAVETOTL macro definitions are also generated and filed as they too are derived from the same data. These macros are called during the generation of the Working-storage section (Section 7 of this appendix).

The body of the TUPLE macro contains the data description statements for all input file items required to solve the user's problem. The macro has the following form:

```
%DEF  TUPLE
%     LABELOFF
          02 data-name PICTURE picture-string USAGE COMPUTATIONAL.
          02 -----
             :
             :
%     LABELON
%END
```

The USAGE COMPUTATIONAL clause is present only in numeric data descriptions.

The body of the SAVETOTL macro contains data description statements for all totalling items, both input and temporary. The general form of the SAVETOTL macro is as follows:

```
%DEF   SAVETOTL
%      LABELOFF
               03 data-name PICTURE picture-string
                  VALUE 0 USAGE COMPUTATIONAL.
               03 -----
                  -----
                  ¦
                  ¦
%      LABELON
%END
```

The numeric item picture-strings for use in the PICTUREDICT subfile and TUPLE macro are generated using logic similar to that shown in Figure 12.2 of Appendix VII. The picture-string used for a totalling item in the SAVETOTL subfile is similarly generated, but the field length is always taken to be 18. This is the maximum size permitted by ICL COBOL for items used in calculations. The picture-string used for alphanumeric data items in both the PICTUREDICT subfile and the TUPLE macro is always X(n), where n is the length of the field as contained in the DOMAININDEX record for the item.

Figure 4.1 summarises the identification and processing for the various data item types described in the DOMAININDEX subfile.

Figure 4.1 Identification and processing of data items

DOMAININDEX subfile record Totalling marker	PICTUREDICT picture-string generated	TUPLE macro data description generated	SAVETOTL macro data description generated
blank	✓	✓	×
T	✓	✓	✓
E	empty string used	×	×
S	empty string used	×	✓

5. FILE SECTION

The File section, the first of the Data division, contains the file and record description statements for all the files used by the program. The statements generated to identify the division and section and those for the output report file are generated without reference to any common data subfiles. However, in order to generate the statements for the input file descriptions use must be made of the data in the SUBMODEL and PICTUREDICT subfiles.

The first six statements generated for the Data division are as follows:

```
DATA DIVISION.
FILE SECTION.
FD  Z-REPORT-FILE
    LABEL RECORDS OMITTED
    DATA RECORD IS Z-OUTREC.
01  Z-OUTREC PICTURE X(n).
```

where n is the page width in terms of the number of characters which can be accomodated. If global variable #GWDTH is equal to 'N' or blank then n has the value 70, otherwise n has the value 120.

The input files have already been designated Z-FILE-1, Z-FILE-2, etc in the order in which their details are recorded in the SUBMODEL subfile (Section 3 of this appendix). The following shows the form of the statements for each of these input file descriptions:

```
FD  Z-FILE-i
    BLOCK CONTAINS block-size CHARACTERS
    RECORD CONTAINS record-size CHARACTERS
    LABEL RECORD STANDARD VALUE OF ID "file-label"
    DATA RECORD IS Z-INRECi.
```

where

i is the ith file described in the SUBMODEL common data file

and

block-size, record-size and file-label are as in the 2nd, 3rd and 4th fields of the ith File name record type 3 of the SUBMODEL subfile.

For character peripherals, i.e. card readers and paper tape readers, the LABEL RECORDS OMITTED clause replaces that shown above.

The file description entries for each user file are generated at three levels using the data in both the SUBMODEL and PICTUREDICT subfiles. The 01 level is the record name as previously designated in the FD statement, i.e

01 Z-INRECi.

where i is the ith data file described in SUBMODEL.

For each input file described in SUBMODEL only those field-names which have a matching record in the PICTUREDICT subfile (Section 4 of this appendix) have a level 03 data description generated. This takes the form:

03 field-name PICTURE picture-string.

A binary search of the PICTUREDICT subfile is made to determine if a matching field-name record exists. If so, the picture-string is extracted from the PICTUREDICT record and used to generate the above COBOL statement.

In addition to the field description statements level 03 FILLER statements are generated when one of the following conditions occurs:

1. The first field in the description does not start in the first position of the record.

2. Two successive fields are not contiguous.

3. The last field of the decription does not end in the last position of the record.

The start position, length of field and the record size details from the SUBMODEL File and Field description records are used to identify the above conditions. The FILLER statements generated have the following form:

03 FILLER PICTURE X(n),

where n is the number of character positions between fields.

The level 02 record description statements are necessary to cope with the cases where SUBMODEL field descriptions are not entered in start position order or when fields overlap. The first level 02 statement for a record description is as follows:

02 Z-IN-RECi-1.

where i is the ith file described in SUBMODEL. Subsequent level 02 statements are generated when either of the conditions mentioned above occurs and takes the form:

02 Z-IN-RECi-k REDEFINES Z-IN-RECi-j.

where k = j + 1 and Z-IN-RECi-j is the name of the previous level 02 statement.

The overall structure of a typical record description is as shown below:

```
01  Z-INREC1.
    02 Z-IN-REC1-1.
       03 FILLER PICTURE ....
       03 data-name-1 PICTURE ....
       03 data-name-2 PICTURE ....
       03 FILLER PICTURE ....
    02 Z-IN-REC1-2 REDEFINES Z-IN-REC1-1.
       03 FILLER PICTURE ....
       03 data-name-3 PICTURE ....
       03 FILLER PICTURE ....
       03 data-name-4 PICTURE ....
       03 FILLER PICTURE ....
```

6. WORKING-STORAGE SECTION LEVEL 77 ENTRIES

The following statements, which define the section and various non-contiguous data items required by the Procedure division of the program, are generated. The use of each variable is outlined in Figure 6.1

```
WORKING-STORAGE SECTION.
77  Z-EOF-1 PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-EOF-2 PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
    ¦
    ¦
77  Z-EOF-n PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-EOF-COUNT PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z PICTURE 9 USAGE COMPUTATIONAL.
77  Z1 PICTURE 9 USAGE COMPUTATIONAL.
77  Z-LINE-COUNT PICTURE 99 VALUE 0 USAGE COMPUTATIONAL.
77  Z-PAGE-SWITCH PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-ADV-LINES PICTURE 99 VALUE 0 USAGE COMPUTATIONAL.
77  Z-IGNORE PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-MAX-LINES PICTURE 99 VALUE 1 USAGE COMPUTATIONAL.
```

where

n is equal to the number of input files as contained in global variable #GNREL

and

l is the maximum number of lines per report page as specified in global variable #GMXLN.

Figure 6.1 Use of level 77 data entries

COBOL data-name	Program usage
Z-EOF-1 Z-EOF-2 ⋮ Z-EOF-n	End of file indicators; one for each input file.
Z-EOF-COUNT	End of file counter; used to determine if all the input files have been read to the end.
Z Z1	Used as subscripts in the calculations which determine the last line on which any sequence break heading or detail print group may start.
Z-LINE-COUNT	Line count variable.
Z-PAGE-SWITCH	Program switch used to indicate that a page heading and sequence break headings, if required, have just been output.
Z-ADV-LINES	Variable used for the ADVANCING option of the first WRITE statement of certain print groups. It is used to carry forward the count of blank lines after the last non-blank line of the previous print group.
Z-IGNORE	Used as a program switch to show that a mis-match file condition has been detected and the 'Ignore' option has been invoked.
Z-MAX-LINES	Maximum number of lines per report page as specified in global variable #GMXLN.

7. GROUP DESCRIPTION ENTRIES

Depending on the user's problem group descriptions may be generated for the following groups:

1. Z-CONTROL-TOTALS
2. Z-LINE-COUNTS
3. Z-CONTROL-BREAK
4. Report line formats
5. Z-TUPLE
6. Z-TUPLE-N

7.1 Z-CONTROL-TOTALS

The Z-CONTROL-TOTALS group description is generated only if the user requested the totalling facility, ie. global variable #GTOT is equal to 1.

A level 02 statement is generated for the final totals and for each intermediate sequence key level except the minor key. The level 02 items are named Z-LEVEL-i where i is the sequence key level number or 0 in the case of final totals. Thus if n is the number of sequence keys in the user's data, as stored in global variable #GNKEY, then i takes the values n-1, n-2, ..., 1, 0.

For each level 02 statement a nested call is made to the SAVETOTL macro (Section 4 of this appendix) which re-generates the level 03 statements for each totalling item.

The following macro-time statements show how the Z-CONTROL-TOTALS group description may be generated:

```
%       IF #GTOT.EQ.0,goto 31
%       #LV1=#GNKEY
                01  Z-CONTROL-TOTALS.
%30     #LV1=#LV1-1
                  02 Z-LEVEL-#LV1.
        [SAVETOTL]
%       IF #LV1.NE.0,GOTO 30
%31     CONTINUE
```

For the model problem described in Section 5.9 of the main text the following statements would be generated:

```
01  Z-CONTROL-TOTALS.
    02 Z-LEVEL-1.
       03 MONTHS-SERVICE PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
       03 NO-EMPLOYEES PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
    02 Z-LEVEL-0.
       03 MONTHS-SERVICE PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
       03 NO-EMPLOYEES PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
```

7.2 Z-LINE-COUNTS

The Z-LINE-COUNTS group contains a data description entry for each sequence break heading, if specified, in major to penultimate minor key order and the detail print group. The data in the Z-LINE-COUNTS group is used by the Procedure division statements to calculate the lowest line of a report page on which the printing of a particular print group may begin. The contents of the group description is redefined so that subscripts may be used in the Procedure division to reference the data items.

The level 02 entries are called Z-L-C-1, Z-L-C-2, etc and each has an initial value assigned. The initial value is equal to the number of lines in the print group represented. The general form of the statements generated for this group description is as follows:

```
01  Z-LINE-COUNTS.
    02 Z-L-C-1 PICTURE 99 VALUE l1 USAGE COMPUTATIONAL.
    02 Z-L-C-2 PICTURE 99 VALUE l2 USAGE COMPUTATIONAL.
       :                  :                  :
    02 Z-L-C-p PICTURE 99 VALUE lp USAGE COMPUTATIONAL.
01  FILLER REDEFINES Z-LINE-COUNTS.
    02 Z-L-C PICTURE 99 OCCURS p TIMES USAGE COMPUTATIONAL.
```

where p is one plus the number of sequence break headings used in the report. The l_1, l_2, ..., l_p values are extracted from the first record of the PAGESBHn subfiles in the case of sequence break headings and the PAGEDETAIL subfile for the detail line print group. The value in global variable #GHEAD indicates whether or

not sequence break headings have been specified by the user.

7.3 Z-CONTROL-BREAK

The Z-CONTROL-BREAK group is used by the Procedure division statements to detect a sequence break in the input data in any key except the minor key. The group contains a level 02 data description for each key in major to penultimate minor key order. The number of keys in the user's data is contained in global variable #GNKEY and the names of the keys are stored in the KEYDICT subfile (Appendix V Section 5). The picture-string for each key is extracted from the corresponding key-name record in the PICTUREDICT subfile (Appendix V Section 10). The general form of the statements generated for the Z-CONTROL-BREAK group is as follows:

```
01  Z-CONTROL-BREAK.
    02 major-key-name PICTURE picture-string.
          ¦                        ¦
          ¦                        ¦
    02 penultimate-minor-key-name PICTURE picture-string.
```

7.4 REPORT LINE FORMATS

The group descriptions for the report line formats of the various categories of output specified by the user were generated during the problem specifying dialogue. They are located in the bodies of the macros with REC as the macro name suffix which were 'grown' during the various stages of the dialogue. The group descriptions are re-generated by making nested calls to these 'grown' macros. Since all the macros were initialised as empty, the macro for any option not invoked by the user will be empty and no statements will be generated. Figure 7.1 shows the names of the macros containing group descriptions for report lines together with a note of the problem specifying stage in which they were 'grown'.

Figure 7.1 'Grown' macros containing report line formats

Macro name	Stage 'grown'	Main text reference
TITLEREC	12	7.20
PHEADREC	13	7.21
SBHREC1 SBHREC2 SBHREC3 SBHREC4 SBHREC5 SBHREC6 SBHREC7 SBHREC8	14	7.22
DETAILREC	10	7.18
STLREC1 STLREC2 STLREC3 STLREC4 STLREC5 STLREC6 STLREC7 STLREC8	15	7.23
TOTLREC	16	7.24

7.5 Z-TUPLE

The Z-TUPLE group contains data descriptions for all the items which are used to solve the user's problem. The group is made up of three parts:

1. The additional data items - date, time and page number.
2. The items in the user's problem domains.
3. User created temporary items.

The statements for parts 2 and 3 have already been generated and they are located in the bodies of the TUPLE and TEMPITEM macros (Section 4 of this appendix and Section 7.12 of the main text). These statements are re-generated by making nested calls

to the macros. The statements generated for the first part of the Z-TUPLE group are always the same and are shown below:

```
01  Z-TUPLE.
    02 ZDATE PICTURE X(8).
    02 ZTIME PICTURE X(8).
    02 Z-PAGE-COUNT PICTURE 9999 VALUE 0 USAGE COMPUTATIONAL.
```

7.6 Z-TUPLE-N

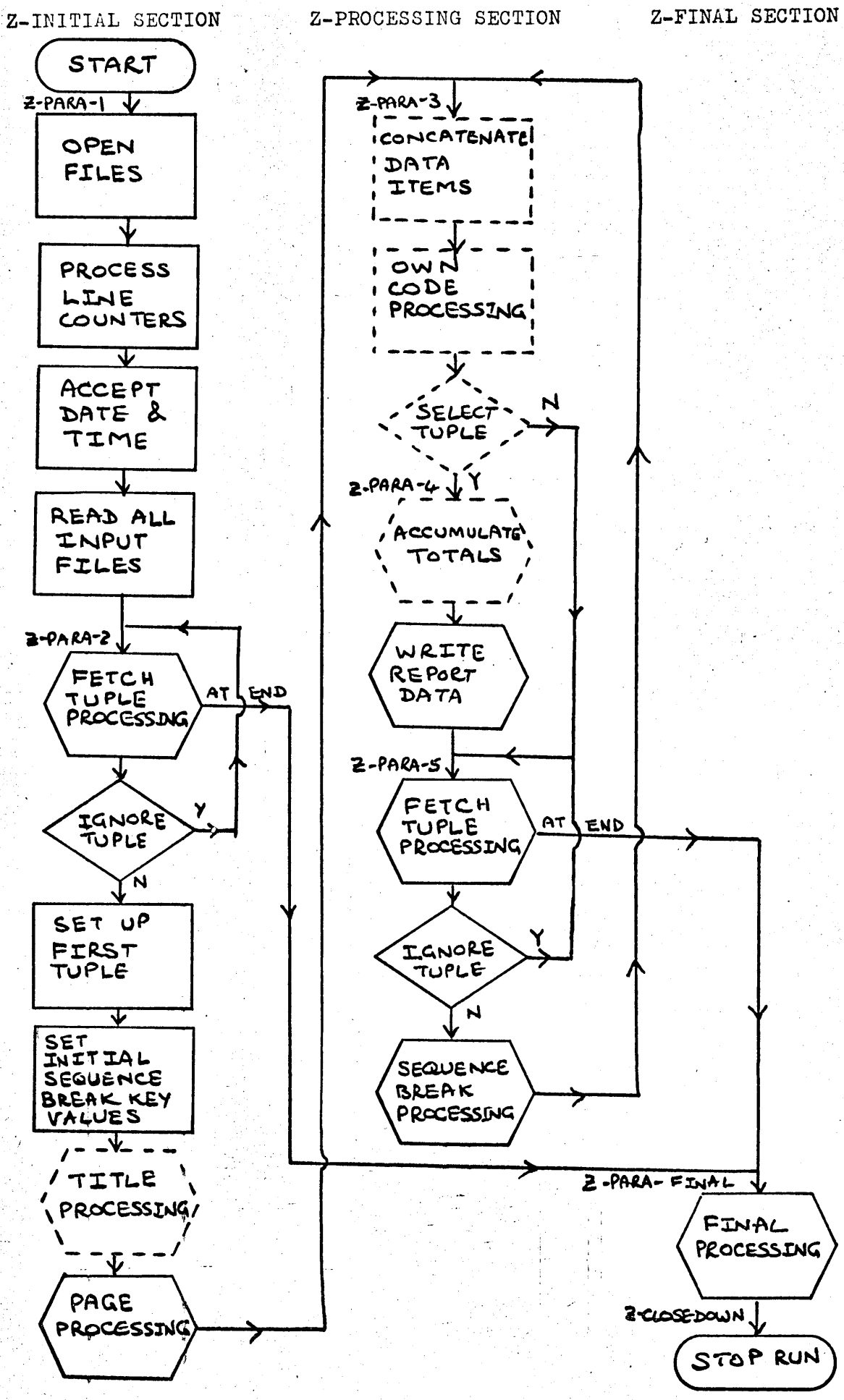
The Z-TUPLE-N group contains descriptions of all the data items from the user's files which are required to solve the problem. (c.f. part 2 of Z-TUPLE.) In the Procedure division, when the input file records have been matched, the input data items are temporarily stored in Z-TUPLE-N. After the sequence break checking has been carried out the Z-TUPLE-N items are moved to the corresponding items in the Z-TUPLE group. The level 02 data description statements for the Z-TUPLE-N group are generated by making a nested call to the TUPLE macro.

8. PROCEDURE DIVISION ENTRIES

The Procedure division processing is based on three main sections, Z-INITIAL, Z-PROCESSING and Z-FINAL (Figure 8.1). In addition there are other sections whose execution is initiated by means of PERFORM statements. Each section consists of several paragraphs. The statements generated for the various sections and paragraphs of the Procedure division are discussed in the subsequent sections of this appendix.

In the general forms of generated statements, which are listed in the subsequent section of this appendix, positions where statements from 'grown' macros are incorporated are indicated by enclosing the macro name in square brackets.

Figure 8.1 Generated COBOL program outline flowchart



9. Z-INITIAL SECTION, PARAGRAPH Z-PARA-1

The processing carried out by the statements generated for the Z-PARA-1 paragraph of the Z-INITIAL section consists of the following:

1. Open all files used by the program.

2. Execute, by means of PERFORM statements using the VARYING option, the Z-END-PAGE-COUNTS and Z-START-LINE procedures which are located in the Z-OTHER-PROCEDURES section. These procedures calculate and store in the Z-L-C data items the last line number on which certain print groups may begin to print.

3. Obtain the run time and date values in character form from the operating system executive by means of ACCEPT operations. Use is made of data names previously defined in the SPECIAL-NAMES paragraph.

4. Execute the own code processing, if any, to be carried out at the start of the processing run. The COBOL statements for this processing step were generated during Stage 18 of the problem specifying dialogue (Section 7.26 of the main text) and are re-generated by making a nested call to the OWNSTART macro.

5. Read the first record from each of the input files by means of PERFORM statements which refer to Sections Z-READ-1, Z-READ-2, etc which are described in Section 27 of this appendix.

The general form of the statements generated for the above processing is shown below:

```
DATA DIVISION.
Z-INITIAL SECTION.
Z-PARA-1. OPEN INPUT
    Z-FILE-1
    Z-FILE-2
      :
      :
    Z-FILE-n
    OUTPUT Z-REPORT-FILE.
    PERFORM Z-END-PAGE-COUNTS VARYING Z FROM p BY -1 UNTIL Z
    EQUALS 1.
    PERFORM Z-START-LINE VARYING Z FROM 1 BY 1 UNTIL Z GREATER
    THAN p.
    ACCEPT ZDATE IN Z-TUPLE FROM Z-DATE.
```

```
ACCEPT ZTIME IN Z-TUPLE FROM Z-TIME.

[OWNSTART]

PERFORM Z-READ-1.
PERFORM Z-READ-2.
  :
  :
PERFORM Z-READ-n.
```

where

n is the number of input files as contained in global variable #GNREL

and

p is equal to 1 if sequence break headings were not specified, i.e. #GHEAD = 0, and equal to #GNKEY if #GHEAD is equal to 1.

10. PARAGRAPH Z-PARA-2

The processing carried out by the statements generated for the Z-PARA-2 paragraph is as follows:

1. Set up the input data for the first tuple in Z-TUPLE-N by performing the Z-FETCH-TUPLE section, whose processing is described in Section 29 of this appendix.

2. Test the Z-IGNORE switch set in Z-FETCH-TUPLE. If it is equal to 1 a file mismatch condition exists which the user wishes to ignore, so processing resumes at step 1 above.

3. Move the input data for the first tuple into the Z-TUPLE group.

4. Set the initial values for the key items in the Z-CONTROL-BREAK group equal to the corresponding items of the first tuple. The Z-CONTROL-BREAK group is later used to detect a sequence break in the input data keys.

5. Execute the own code processing to be carried out prior to writing the report title. The COBOL statements for this step are in the body of the OWNTITL macro which was 'grown' during the

problem specifying dialogue (Section 7.18 of main text). They are regenerated by making a nested call to the OWNTITL macro.

6. Write out the Report title, if specified, by performing the Z-PARA-TITLE paragraph of the Z-OTHER-PROCEDURES section.

N.B. The statements for steps 5 and 6 are only generated if global variable #GTITL is equal to 1.

7. Skip to the top of a new report page and write out the page heading etc, if specified. This processing is carried out by performing the Z-PARA-PAGE paragraph in the Z-OTHER-PROCEDURES section.

The statements generated for the above processing are as follows:

```
Z-PARA-2.
    PERFORM Z-FETCH-TUPLE. IF Z-IGNORE EQUALS 1 GO TO Z-PARA-2.
    MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.

    [OWNRETR]

    MOVE CORRESPONDING Z-TUPLE TO Z-CONTROL-BREAK.

    [OWNTITL]

    PERFORM Z-PARA-TITLE.
    PERFORM Z-PARA-PAGE.
```

11. Z-PROCESSING SECTION, PARAGRAPH Z-PARA-3

In the Z-PARA-3 paragraph the following three tasks may be carried out:

1. Execute the MOVE operations which concatenate data into the compound temporary items, if any were created by the user (Section 7.12 of main text). The COBOL statements, if any, for this processing are located in the body of the CONCAT macro and may be regenerated by making a nested call to the macro.

2. Execute the own code processing, if any, to be carried out after a data retrieval. The COBOL statements for this processing task were generated during Stage 18 of the problem

specifying dialogue (Section 7.26 of main text). They are regenerated by making a nested call to the OWNRETR macro.

3. Apply the data selection conditions, if any, specified during the problem specifying dialogue. If the conditions are satisfied control passes to paragraph Z-PARA-4, otherwise it passes to Z-PARA-5. The COBOL statements for this task are located in the body of the SELCOND macro (Section 7.14 of main text) and are regenerated by making a nested call to the macro.

The statements generated for the above processing are as follows:

```
Z-PROCESSING SECTION.
Z-PARA-3.

    [CONCAT]

    [OWNRETR]

    [SELCOND]
```

12. PARAGRAPH Z-PARA-4

One or two tasks are performed in the Z-PARA-4 paragraph depending on whether or not the user requested the totalling facility:

1. If totalling was requested the Z-PARA-ADD paragraph, which accumulates the required data values, is executed by means of a PERFORM statement. This statement is only generated if global variable #GTOT is equal to 1.

2. The Z-PARA-WRITE paragraph is performed so that the detail line(s) for the current data retrieval are written on the Report file.

The Z-PARA-ADD and Z-PARA-WRITE paragraphs are located in the Z-OTHER-PROCEDURES section and are described later.

The statements generated for the Z-PARA-4 paragraph are as follows:

```
Z-PARA-4.
    PERFORM Z-PARA-ADD.
    PERFORM Z-PARA-WRITE.
```

13. PARAGRAPH Z-PARA-5

The processing carried out by the statements generated for the Z-PARA-5 paragraph is as follows:

1. Set up the input data for the next tuple in the Z-TUPLE-N group by performing the Z-FETCH-TUPLE section.

2. Test the Z-IGNORE switch set in the Z-FETCH-TUPLE section. If it is equal to 1 the user wishes to ignore a file mismatch condition, so processing resumes at step 1 above.

3. Execute the Z-SEQUENCE-BREAK section by means of a PERFORM statement. This section detects and processes an input data sequence break condition and is described later.

4. Pass control to the Z-PARA-3 paragraph where the next tuple is processed.

The statements generated for the Z-PARA-5 paragraph are shown below and are always the same as they are independent of the user's problem:

```
Z-PARA-5. PERFORM Z-FETCH-TUPLE.
IF Z-IGNORE EQUALS 1 GO TO Z-PARA-5.
PERFORM Z-SEQUENCE-BREAK. GO TO Z-PARA-3.
```

14. Z-FINAL SECTION, PARAGRAPH Z-PARA-FINAL

If totalling was not specified by the user, i.e. global variable #GTOT is equal to zero, the Z-PARA-FINAL paragraph is a null paragraph and only the following statements are generated for it:

```
Z-FINAL SECTION.
Z-PARA-FINAL. EXIT.
```

If, however, the totalling facility was invoked the following processing is carried out in the Z-PARA-FINAL paragraph:

1. Process the sequence break subtotals in penultimate minor to major key order. This processing is initiated by PERFORM statements which refer to the Z-TOTALi paragraphs, where i is the sequence key level. These paragraphs are in the Z-OTHER-PROCEDURES section and are described later.

2. Test the value of the line counter to see if there is enough room at the bottom of the page for all the lines of the final totals print group. If there is insufficient space take a new page by performing the page heading paragraph Z-PARA-PAGE.

3. Obey the user's own code processing, if any, specified for execution prior to printing the final totals. The COBOL statements for this own code processing were generated during the problem specifying dialogue (Section 7.26 of main text) and are located in the body of the OWNTOTL macro. They are regenerated by making a nested call to the OWNTOTL macro.

4. Output the totals in the user specified format by performing the Z-TOTALO-WRITE paragraph located in the Z-OTHER-PROCEDURES section.

COBOL statements for steps 2 to 4 are generated only if totals output was specified by the user, i.e. global variable is #GTOTL is equal to 1.

If the totalling facility was used and totals output is required the general form of the statements generated for the Z-PARA-FINAL paragraph is as shown below:

```
Z-FINAL SECTION.
Z-PARA-FINAL.
    PERFORM Z-TOTALi.
        ⋮
    PERFORM Z-TOTAL1.
    IF Z-LINE-COUNT IS GREATER THAN 1 PERFORM Z-PARA-PAGE.

    [OWNTOTL]

    PERFORM Z-TOTALO-WRITE..
```

where

i takes the values n-1, n-2, ..., 1 and n is the number of

sequence key levels as contained in global variable #GNKEY and

1 is the value in global variable #GMXLN minus the value in the control record of the PAGETOTL work subfile (Appendix V Section 9).

15. PARAGRAPH Z-CLOSE-DOWN

The Z-CLOSE-DOWN paragraph carries out two tasks:

1. Close all the input files and the output report file.
2. Stop the program run.

The statements generated for this paragraph have the following general form:

```
Z-CLOSE-DOWN. CLOSE
    Z-FILE-1
    Z-FILE-2
      ¦
      ¦
      ¦
    Z-FILE-n
    Z-REPORT-FILE. STOP RUN.
```

where n is the number of input files as contained in global variable #GNREL.

16. Z-OTHER-PROCEDURES SECTION

The Z-OTHER-PROCEDURES section is a convenient means of grouping a number of paragraphs which do not fit into any of the other sections of the Procedure division. The execution of each paragraph is initiated by means of a PERFORM statement. With the exception of the Z-TOTALi, Z-HEADi and Z-HEADi-EXIT paragraphs, the ordering of paragraphs within the section is quite arbitrary. Depending on the user's problem the statements for some paragraphs may not be generated.

The following statement is generated to define the section:

```
Z-OTHER-PROCEDURES SECTION.
```

17. PARAGRAPH Z-PARA-ADD

The Z-PARA-ADD paragraph is only generated if the totalling facility was invoked by the user, i.e. global variable #GTOT is equal to 1.

The processing in this paragraph causes the totalling items from the current tuple to be added to the corresponding items at the penultimate minor key level of the Z-CONTROL-TOTALS group.

If generated, the statement for the Z-PARA-ADD paragraph is as follows:

Z-PARA-ADD. ADD CORRESPONDING Z-TUPLE TO Z-LEVEL-i.

where i is equal to n-1 and n is the value in global variable #GNKEY.

18. PARAGRAPH Z-PARA-WRITE

The processing in the Z-PARA-WRITE paragraph consists of the following:

1. Test the line counter to see if there is enough room on the current report page to output the detail line(s) for the current tuple. If there is not enough space a new page is taken by performing the page heading paragraph Z-PARA-PAGE.

2. Carry out the own code processing, if any, specified by the user during the problem specifying dialogue for execution prior to printing the detail line(s) for the current tuple (Section 7.26 of the main text). The COBOL statements for this step are located in the body of the OWNDETAIL macro and are regenerated by making a nested call to it.

3. Output the detail line(s) for the current tuple in the format specified during the problem dialogue (Section 7.18 of main text). The body of the WRITEPARA macro contains the COBOL statements for this step and they may be regenerated by making a

nested call to the macro.

The statements generated for the Z-PARA-WRITE paragraph have the following general form:

```
Z-PARA-WRITE.
    IF Z-LINE-COUNT GRATER THAN Z-L-C(1) PERFORM Z-PARA-PAGE.
    [OWNDETAIL]
    [WRITEPARA]
```

where 1 is equal to 1 if sequence break headings were not specified, i.e. global variable #GHEAD is equal to zero, and equal to #GNKEY if #GHEAD is equal to 1.

19. PARAGRAPHS Z-END-PAGE-COUNTS AND Z-START-LINE

The calculations for determining the last line of a report page on which any sequence break heading or detail line print group may begin are delayed until the COBOL program is executed. This is because the necessary calculations are cumbersome to effect using the PG/2 macro processor facilities which do not support subscripts and array variables.

These calculations aim to avoid sequence break headings appearing at the foot of a report page and to prevent incomplete print groups from having to be continued on the next report page. A sequence break heading is not output to a report page unless there is also room for all the sequence break headings minor to it and at least one set of detail output.

The execution of the statements in the Z-END-PAGE-COUNTS and Z-START-LINE paragraphs is initiated by PERFORM statements in the Z-PARA-1 paragraph of the Z-INITIAL section (Section 9 of this appendix). Use is made of the data items in the Z-LINE-COUNTS group which are referenced by means of subscript variables Z and Z1.

The following statements are generated for these paragraphs:

```
Z-END-PAGE-COUNTS. COMPUTE Z1 = Z - 1.
    ADD Z-L-C(Z) TO Z-L-C(Z1).
Z-START-LINE. COMPUTE Z-L-C(Z) = Z-MAX-LINES - Z-L-C(Z).
```

20. PARAGRAPHS Z-HEADi AND Z-HEADi-EXIT

Paragraphs Z-HEADi and Z-HEADi-EXIT control the writing out of the sequence break heading at the ith key level. Statements for these paragraphs are only generated if the user specified sequence break headings, i.e. global variable #GHEAD is equal to 1 (Section 7.22 of main text). A pair of paragraphs is generated for each sequence break heading in the user's report, i.e. i takes the values 1 to n-1 where n is number of sequence keys as in global variable #GNKEY. The execution of these paragraphs is initiated by a PERFORM ... THRU ... statement in the Z-SEQUENCE-BREAK section.

The processing carried out by each pair of paragraphs consists of the following steps:

1. Test the value of Z-LINE-COUNT to see if there is enough room on the report page to print the sequence break heading. If there is insufficient space continue at step 4, otherwise continue below.

2. Test the state of the page switch Z-PAGE-SWITCH. If it is equal to 1 a new page has just been taken so control passes to step 6 as there is no need to repeat the sequence break heading.

3. Output the sequence break heading for the ith key level by performing the Z-HEADi-WRITE paragraph. Continue processing at step 5.

4. Skip to a new page and output the headings by performing the Z-PARA-PAGE paragraph.

5. Exit from the range of the PERFORM statement.

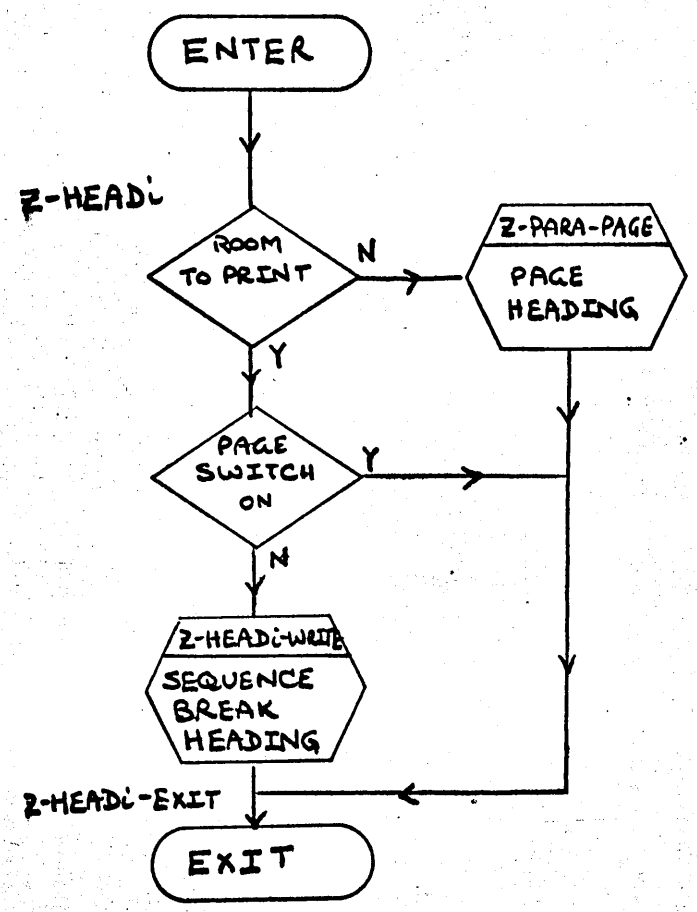
The above processing is illustrated in Figure 20.1 and the

form of the COBOL statements generated for these pairs of paragraphs is shown below:

```
Z-HEADi.
    IF Z-LINE-COUNT GREATER THAN Z-L-C(i) PERFORM Z-PARA-PAGE
    GO TO Z-HEADi-EXIT.
    IF Z-PAGE-SWITCH EQUALS 1 GO TO Z-HEADi-EXIT.
    PERFORM Z-HEADi-WRITE.
Z-HEADi-EXIT. EXIT.
```

where i is equal to the sequence break key level which takes the values 1 to n-1, where n is the value in global variable #GNKEY.

Figure 20.1 Outline processing for sequence break headings



21. PARAGRAPHS Z-TOTALi

Paragraph Z-TOTALi controls the summation and writing out of the sequence break subtotals at key level i. The statements for these paragraphs are generated only if the totalling facility was invoked, i.e. if global variable #GTOT is equal to 1.

COBOL statements for steps 1 to 4 of the processing carried out in this paragraph and described below are generated only if sequence break subtotal output was specified by the user, i.e. global variable #GSUBT is equal to 1 (Section 7.23 of main text).

1. Test the line counter Z-LINE-COUNT to see if there is room for the subtotals print group on the current page. If there is insufficient space take a new page by performing the Z-PARA-PAGE paragraph.

2. If own code processing was specified for execution prior to printing the subtotals at the current key level carry out this processing. The COBOL statements for this own code processing were generated during the problem specifying dialogue and are located in the body of the OWNSTLi macro, where i is the current key level. These COBOL statements are regenerated by making a nested call to the OWNSTLi macro.

3. Output the subtotals for the current key level by performing the Z-TOTALi-WRITE paragraph.

4. Turn the page switch off by setting Z-PAGE-SWITCH equal to zero. This indicates that a non-heading print group has just been output to the report page.

5. Add the subtotals of items at the current key level to the corresponding items of the next key level major to it.

6. Zeroise the subtotals of items at the current key level.

The general form of the COBOL statements generated for these paragraphs is show below:

```
Z-TOTALi.
    IF Z-LINE-COUNT GREATER THAN 1 PERFORM Z-PARA-PAGE.

    [OWNSTLi]

    PERFORM Z-TOTALi-WRITE.
    MOVE 0 TO Z-PAGE-SWITCH.
    ADD CORRESPONDING Z-LEVEL-i TO Z-LEVEL-j.
    SUBTRACT CORRESPONDING Z-LEVEL-i FROM Z-LEVEL-i.
```

where

i is the current key level which takes the values n-1 to 1, where n is the number of sequence keys as in global variable #GNKEY.

j is equal to i-1,

and

1 is equal to the value in global variable #GMXLN minus the value in the contol record of the PAGESTLi work subfile. (Appendix VII Section 16 and Appendix V Section 9).

22. PARAGRAPH Z-PARA-TITLE

The Z-PARA-TITLE paragraph is only present in the generated COBOL program if the user specified a Report title during the problem dialogue (Section 7.20 of the main text). The COBOL statements for this paragraph were generated at the time of the dialogue and are located in the body of the TITLEPARA macro. They may be regenerated by making a nested call to the TITLEPARA macro.

23. PARAGRAPH Z-PARA-PAGE

The Z-PARA-PAGE paragraph controls the skip to the top of the next page of the report, the incrementing of the page counter and the output of headings, if specified.

The processing steps are as follows:

1. Carry out the own code processing, if any, specified

during the problem dialogue for execution prior to the output of a page heading. The COBOL statements for this processing were generated at the time of the dialogue and are located in the body of the OWNPAGE macro (Appendix VII Section 26). They may be regenerated by making a nested call to the macro.

2. Clear the output file record area Z-OUTREC to spaces.

3. Increment the page counter Z-PAGE-COUNT by 1.

4. Skip to the top of a new report page by writing out a blank line on the report and then skipping to channel 1.

5. Output the page heading, if specified by the user during the problem dialogue (Section 7.21 in main text). The COBOL statements for this step are located in the body of the PHEADPARA macro and may be regenerated by making a nested call to the macro.

6. Write out the sequence break headings for all key levels in major to penultimate minor key order by performing the Z-HEADi-WRITE paragraphs, where i denotes the key level. The COBOL statments for this step are only generated if sequence break headings were specified by the user, i.e. if global variable #GHEAD is equal to 1.

The general form of the COBOL statements generated for the Z-PARA-PAGE paragraph is as follows:

```
Z-PARA-PAGE.

    [OWNPAGE]

    MOVE SPACES TO Z-OUTREC. ADD 1 TO Z-PAGE-COUNT IN Z-TUPLE.
    WRITE Z-OUTREC BEFORE ADVANCING CHANNEL-1.

    [PHEADPARA]

    PERFORM Z-HEAD1-WRITE.
        :
        :
    PERFORM Z-HEADi-WRITE.
```

where i is equal to the value in global variable #GNKEY minus 1.

24. PARAGRAPHS Z-HEADi-WRITE

The Z-HEADi-WRITE paragraph writes out the lines of the sequence break heading for the ith key level. If sequence break headings were specified during the problem dialogue, i.e. global variable #GHEAD is equal to 1, a paragraph is generated for each key level except the minor key.

The tasks carried out by the COBOL statements generated for each Z-HEADi-WRITE paragraph are as follows:

1. The own code processing, if any, specified during the problem dialogue for execution prior to the output of the sequence break heading at the current key level, is carried out. The COBOL statements for this task are located in the OWNSBHi macro subfile and may be regenerated by making a nested call to the macro (Appendix VII Section 26).

2. The lines of the sequence break heading for the current key level are set up and written out. The SBHPARAi macro contains the COBOL statements for this step which were generated during the problem dialogue (Section 7.22 of main text). They may be regenerated by making a nested call to the SBHPARAi macro (Appendix VII Section 22).

The general form of the statements generated for the Z-HEADI-WRITE paragraphs is as follows:

```
Z-HEADi-WRITE.
    [OWNSBHi]
    [SBHPARAi]
```

where i is the sequence key level and takes the values 1, 2, ..., n-1 and n is the value in global variable #GNKEY.

25. PARAGRAPHS Z-TOTALi-WRITE

These paragraphs are generated only if the totalling facility was invoked and sequence break subtotals were specified during the problem dialogue, i.e. global variables #GTOT and #GSUBT are both equal to 1. A Z-TOTALi-WRITE paragraph is generated for each key level i except the minor key.

Each Z-TOTALi-WRITE paragraph carries out two tasks, the COBOL statements for which were generated during the problem specifying dialogue:

1. Carry out the own code processing, if any, to be executed prior to writing the current sequence break subtotals. The COBOL statements for this task are located in the body of the OWNSTLi macro and are regenerated by making a nested call to the macro (Appendix VII Section 26).

2. Write out the lines of the sequence break subtotals print group for the current key level in the format specified by the user. The STLPARAi macro contains the COBOL statements for this task, where i is the current key level. The statements may be regenerated by making a nested call to the macro (Appendix VII Section 23).

The general form of the statements generated for the Z-TOTALi-WRITE paragraph is as follows:

```
Z-TOTALi-WRITE.
    [OWNSTLi]
    [STLPARAi]
```

where i is the sequence key level and takes the values 1, 2, ..., n-1 and n is the value in global variable #GNKEY.

26. PARAGRAPH Z-TOTALO-WRITE

The Z-TOTALO-WRITE paragraph is present in the generated program only if the user invoked the totalling facility and specified totals output during the problem dialogue, i.e. global variables #GTOT and #GTOTL are both equal to 1 (Section 7.24 of main text).

The Z-TOTALO-WRITE paragraph carries out two tasks, the COBOL statements for which were generated during the problem specifying dialogue:

1. Carry out the own code processing, if any, to be executed prior to writing the final totals. The COBOL statements for this task are located in the body of the OWNTOTL macro and are regenerated by making a nested call to the macro (Appendix VII Section 26).

2. Write out the lines of the final totals print group. The TOTLPARA macro contains the statements for this task and they may be regenerated by making a nested call to the macro (Appendix VII Section 24).

The form of the statements generated for this paragraph is as follows:

```
Z-TOTALO-WRITE.
    [OWNTOTL]
    [TOTLPARA]
```

27. Z-READ-i SECTION

For each input file used by the COBOL program a Z-READ-i section is generated. The files are numbered in the order in which they are described in the SUBMODEL work subfile. Thus i takes the values 1 to n, where n is the value in global variable #GNREL.

Input files whose number of sequence keys is equal to the value in global variable #GNKEY are, for the purposes of the COBOL generating sysytem, designated 'Master' files. Master files are processed in a different way from non-master files. In order to determine whether or not a file is a master file it is necessary to inspect the eigth field of the File name type 3 record in the SUBMODEL subfile (Appendix V Section 3). A count of the number of master files described in SUBMODEL is maintained in global variable #GMSTR. This value is later used in the generation of the Z-FETCH-TUPLE section.

In the processing carried out in each of these sections a record is read from the input file. If the end of file is detected the end of file indicator (Appendix VIII Section 6) is set equal to 1. If the file is a master file the value of Z-EOF-COUNT is incremented by 1 when the end is reached.

The execution of these sections is initiated by means of PERFORM statements within other sections of the program. The general form of the statements generated for each section is shown below:

```
Z-READ-i SECTION.
Z-READ-i-1. READ Z-FILE-i AT END GO TO Z-READ-i-2.
    GO TO Z-READ-i-EXIT.
Z-READ-i-2. MOVE 1 TO Z-EOF-i.
    ADD 1 TO Z-EOF-COUNT.
Z-READ-i-EXIT. EXIT.
```

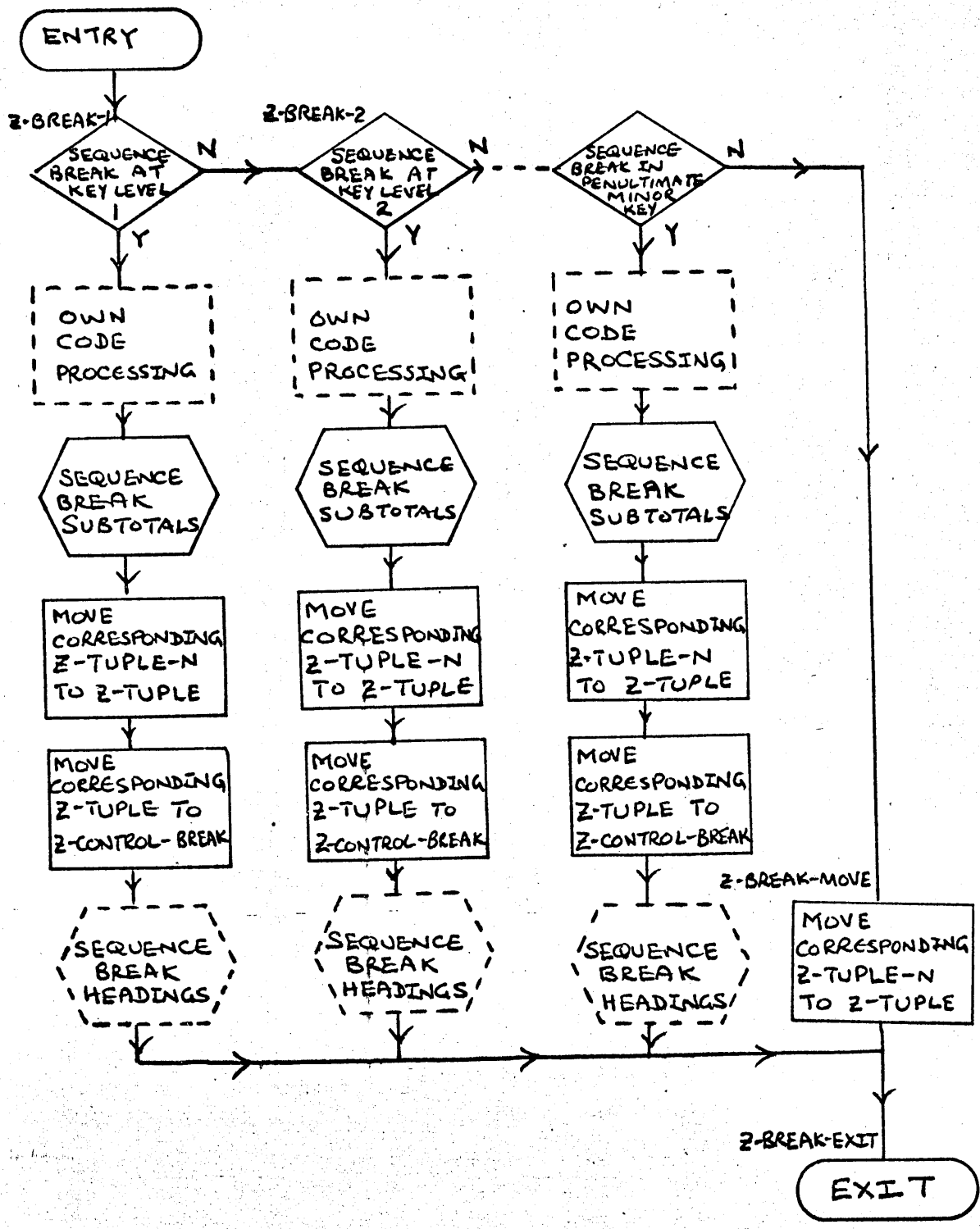
where i is the file number which takes the values 1 to n and n is the value in global variable #GNREL.

N.B. The ADD statement in the third paragraph is generated only if the file is a master file.

28. Z-SEQUENCE-BREAK SECTION

The proqessing in the Z-SEQUENCE-BREAK section detects a sequence break in any key level except the minor and controls the output of sequence break subtotals and headings, if specified.

Figure 28.1 Outline processing for the Z-SEQUENCE-BREAK section



The section consists of pairs of paragraphs, one pair for each key level except the minor key. These paragraphs are called Z-BREAK-i and Z-BREAK-i-EXIT, where i denotes the key level. The section concludes with two other paragraphs, Z-BREAK-MOVE and Z-BREAK-EXIT. The general structure of this section is illustrated in Figure 28.1.

The processing within the pairs of Z-BREAK-i and Z-BREAK-i-EXIT paragraphs is as follows:

1. Test to see if there is a change in the value of the key at the current level, i.e. compare its value in the Z-TUPLE-N and Z-CONTROL-BREAK groups. If the values are the same continue processing at step 7, otherwise continue below.

2. If own code processing was specified for execution at a sequence break in the current key level, carry out this processing. The COBOL statements for this own code processing were generated during the problem specifying dialogue and are located in the OWNSBHi macro, where i is the current key level. These COBOL statements are regenerated by making a nested call to the OWNSBHi macro (Appendix VII Section 26).

3. Carry out the sequence break subtotals processing for the current key level and all levels minor to it. These are executed in minor to major key sequence. The COBOL statements for this step are generated only if the totalling facility has been invoked, i.e. global variable #GTOT is equal to 1.

4. Move the input data items from the Z-TUPLE-N group to the Z-TUPLE group.

5. Update the values of the keys in the Z-CONTROL-BREAK group by setting them equal to those in the Z-TUPLE group.

6. Output the sequence break headings for the current key level and all keys minor to it. The COBOL statements for this step are generated only if sequence break headings were specified

by the user during the problem dialogue, i.e. global variable #GHEAD is equal to 1 (Section 7.22 of main text).

7. Exit from the processing at the current key level.

The Z-BREAK-MOVE paragraph is executed when there is no sequence break in the input data. It causes the data from the Z-TUPLE-N group to be moved to the Z-TUPLE group read for processing.

The Z-BREAK-EXIT paragraph consists only of an EXIT statement and provides a common end to the processing paths within the section.

The general form of the COBOL statements generated for the Z-SEQUENCE-BREAK section is as follows. The KEYDICT common data subfile (Appendix V Section 5) is referenced in order to relate the sequence key level to the corresponding key name.

```
Z-SEQUENCE-BREAK SECTION.
Z-BREAK-i.
    IF key-i IN Z-TUPLE-N EQUALS key-i IN
    Z-CONTROL-BREAK GO TO Z-BREAK-i-EXIT.

    [OWNSBHi]

    PERFORM Z-TOTALj THRU Z-TOTALi.
    MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.
    MOVE CORRESPONDING Z-TUPLE TO Z-CONTROL-BREAK.
    PERFORM Z-HEADi THRU Z-HEADj-EXIT.
    GO TO Z-BREAK-EXIT.
Z-BREAK-i-EXIT. EXIT.
     .
     .
     .
     .
Z-BREAK-MOVE. MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.
Z-BREAK-EXIT. EXIT.
```

where

i is the sequence break key level which takes the values 1 to n-1, where n is the value in global variable #GNKEY

and

j is equal to n-1, where n is the value in global variable #GNKEY.

key-i is the name of the ith sequence key as found in the ith record of the KEYDICT subfile.

N.B. When n is equal to 2 the THRU option is omitted from the PERFORM Z-TOTAL1 statement.

29. Z-FETCH-TUPLE SECTION

The processing carried out in this section matches the records from the various input files and from them selects the data for the current tuple in the Z-TUPLE-N group. It also detects when all the input data has been processed and handles the file mismatch condition according to the option selected by the user during the problem dialogue (Section 7.13 of main text).

The three main tasks within the section are listed below together with the name of the paragraph at which the task processing begins:

1. End of data test (Z-END-OF-DATA-TEST).
2. Set tuple keys (Z-SET-TUPLE-KEY).
3. Set up non-key tuple data and process file mismatch condition (Z-SET-TUPLE-DATA-1).

The COBOL statements generated for processing each input file depend on whether or not the file is a Master file (Section 27 of this appendix). In order to generate the statements for this section reference is made to the data in the SUBMODEL, KEYDICT and DOMAININDEX common data subfiles.

The following statement is generated to define the section:

Z-FETCH-TUPLE SECTION.

30. PARAGRAPH Z-END-OF-DATA-TEST

When all the records on all the master files have been read and processed the end of data is deemed to have been reached. This condition is detected by testing the Z-EOF-COUNT variable which is incremented by 1 each time the end of a master file is

reached (Section 27 of this appendix). If Z-EOF-COUNT is equal to the value in global variable #GMSTR then control is passed to the Z-FINAL section. If the end of data has not been reached the Z-IGNORE switch is turned off by moving a zero to it.

The COBOL statements generated for this paragraph are as follows:

```
Z-END-OF-DATA-TEST. IF Z-EOF-COUNT EQUALS m GO TO Z-FINAL.
    MOVE 0 TO Z-IGNORE.
```

where m is the value in global value #GMSTR, i.e. the number of master files used by the program.

31. PARAGRAPH Z-SET-TUPLE-KEY

In this paragraph the sequence keys of all the master files are compared in order to find the file with the lowest key. The key values from this file are moved to the key items in the Z-TUPLE-N group.

The flowchart in Figure 31.1 shows the outline processing for the above task when more than one master file is used by the generated program. If only one master file is used the flowchart can be simplified so that only the block marked with an asterisk is retained.

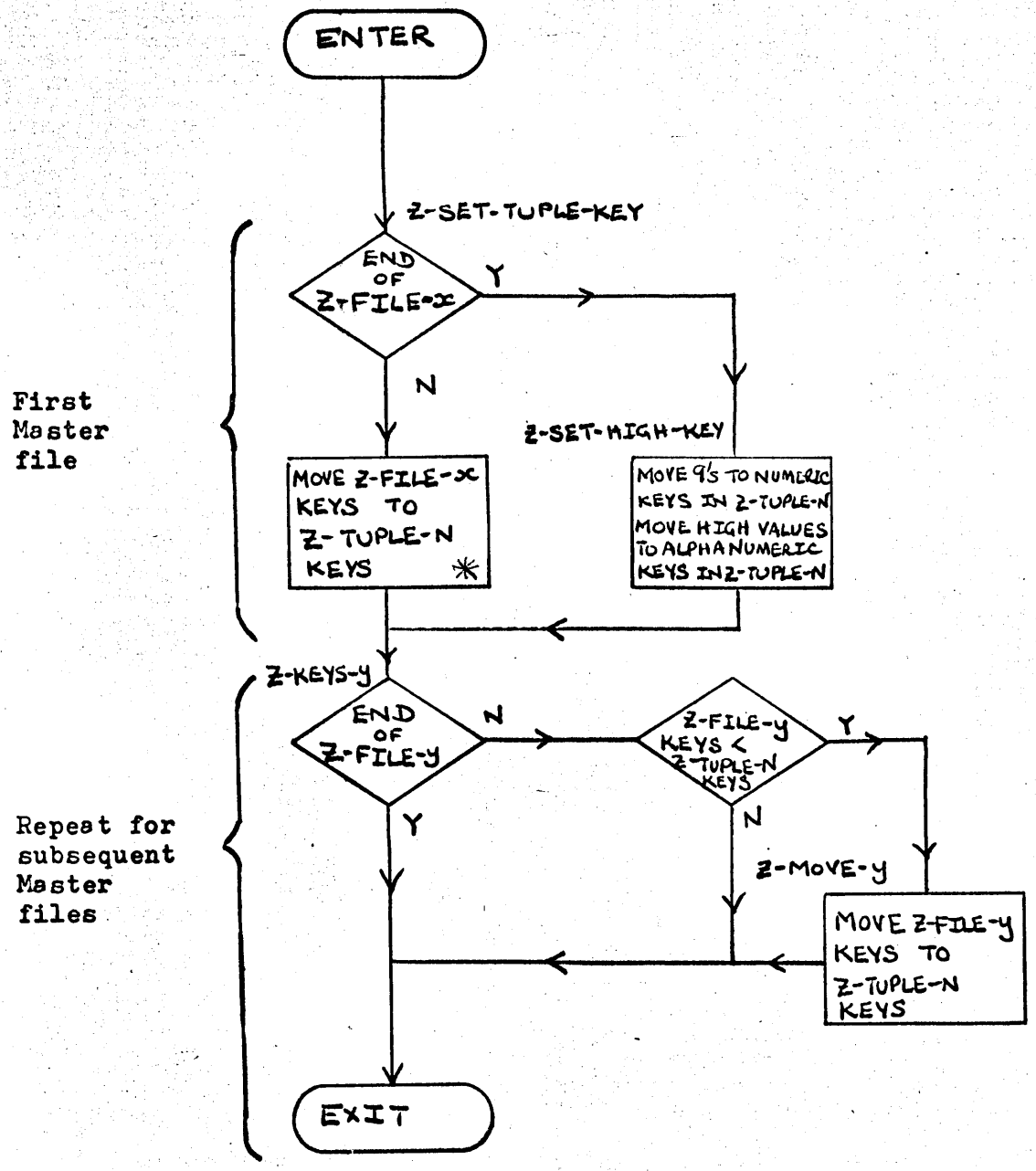
In the simplified case with only one master file the following shows the general form of the COBOL statements generated for the Z-SET-TUPLE-KEY paragraph:

```
Z-SET-TUPLE-KEY.
    MOVE key-1 IN Z-INRECx TO key-1
    IN Z-TUPLE-N.
    MOVE key-2 IN Z-INRECx TO key-2
    IN Z-TUPLE-N.
            :
    MOVE key-n IN Z-INRECx TO key-n
    IN Z-TUPLE-N.
```

where the master file is the xth file described in the SUBMODEL common data subfile.

Key-1, key-2, ..., key-n are the key names from the KEYDICT subfile

Figure 31.1 Outline processing for setting the Tuple keys



and n is the number of sequence keys as contained in global variable #GNKEY.

When more than one master file is used the general form of the COBOL statements generated for setting up the tuple key is as follows:

```
Z-SET-TUPLE-KEY.
    IF Z-EOF-x EQUALS 1 GO TO Z-SET-HIGH-KEY.
    MOVE key-1 IN Z-INRECx TO key-1
    IN Z-TUPLE-N.
    MOVE key-2 IN Z-INRECx TO key-2
    IN Z-TUPLE-N.
         :
         :
    MOVE key-n IN Z-INRECx TO key-n
    IN Z-TUPLE-N.
    GO TO Z-SET-CONTINUE.
Z-SET-HIGH-KEY.
    MOVE high-constant TO key-1 IN Z-TUPLE-N.
    MOVE high-constant TO key-2 IN Z-TUPLE-N.
         :
         :
    MOVE high-constant TO key-n IN Z-TUPLE-N.
Z-SET-CONTINUE. EXIT.
```

First master file

```
Z-KEYS-y. IF Z-EOF-y EQUALS 1 GO TO Z-KEYS-y-EXIT.
    IF key-1 IN Z-INRECy GREATER THAN
    key-1 IN Z-TUPLE-N GO TO Z-KEYS-y-EXIT.
    IF key-1 IN Z-INRECy LESS THAN
    key-1 IN Z-TUPLE-N GO TO Z-MOVE-y-1.
    IF key-2 IN Z-INRECy GREATER THAN
    key-2 IN Z-TUPLE-N GO TO Z-KEYS-y-EXIT.
    IF key-2 IN Z-INRECy LESS THAN
    key-2 IN Z-TUPLE-N GO TO Z-MOVE-y-2.
         :
         :
    IF key-n IN Z-INRECy GREATER THAN
    key-n IN Z-TUPLE-N GO TO Z-KEYS-y-EXIT.
    IF key-n IN Z-INREXy LESS THAN
    key-n IN Z-TUPLE-N GO TO Z-MOVE-y-n.
    GO TO Z-SET-KEYS-y-EXIT.
Z-MOVE-y-1. MOVE key-1 IN Z-INRECy TO
    key-1 IN Z-TUPLE-N.
Z-MOVE-y-2. MOVE key-2 IN Z-INRECy TO
    key-2 IN Z-TUPLE-N.
         :
         :
Z-MOVE-y-n. MOVE key-n IN Z-INRECy TO
    key-n IN Z-TUPLE-N.
Z-KEYS-y-EXIT. EXIT.
```

Other master files

where

x denotes the number of the first master file described in the SUBMODEL common data subfile.

y denotes the number of a subsequent master file described in the SUBMODEL subfile.

key-1, key-2, ..., key-n are the key names from the KEYDICT subfile and n is the number of sequence keys as contained in global variable #GNKEY. The keys are in major to minor key order.

high-constant is the figurative constant HIGH-VALUES when the key is of alphanumeric type. For a numeric type key it is a numeric literal such that all digit positions of the tuple key field will be filled with 9's. The type, length and decimal point location of the key field is described in its DOMAININDEX subfile record.

32. PARAGRAPH Z-SET-TUPLE-DATA-1.

In the Z-SET-TUPLE-DATA-1 and subsequent paragraphs the keys in the input file records are matched against the keys in the Z-TUPLE-N group. If a file record with matching keys exists the non-key items are moved from the record to the corresponding items in the Z-TUPLE-N group. If, for any file, a matching key record cannot be found, the error option selected by the user is carried out (Section 7.13 of main text).

During the search for matching records more than one pass through a non-master file may be required, but for master files only one pass is made. The files are processed in the order in which they are described in the SUBMODEL subfile. The processing of master and non-master files differs and the details are illustrated in Figures 32.1 and 32.2. When only one master file is required to solve the problem, the flowchart can be simplified so that only the blocks marked with an asterisk are retained.

Figure 32.1 Outline processing for setting up tuple data from a master file

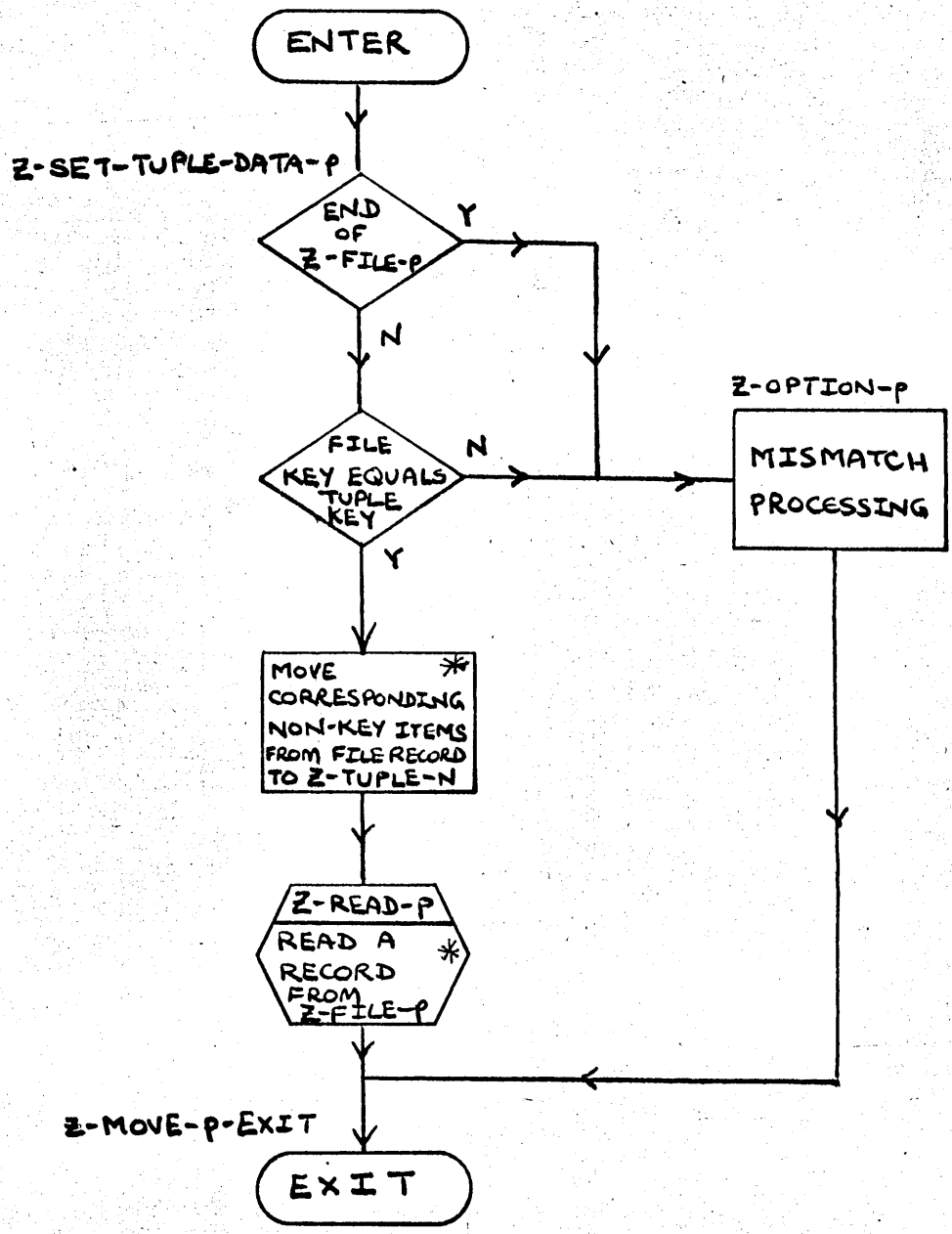
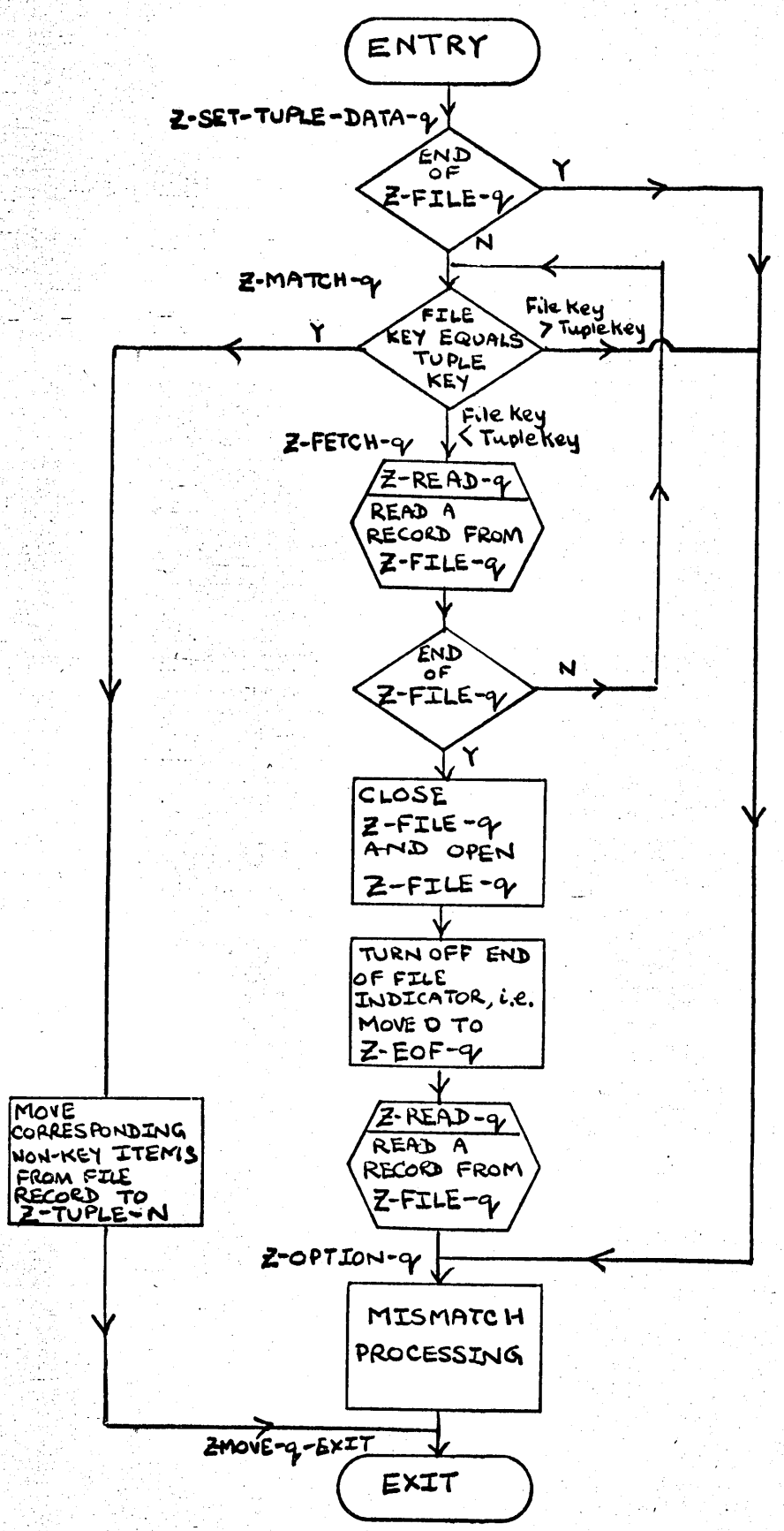


Figure 32.2 Outline processing for setting up tuple data from a non-master file



The general form of the COBOL statements generated to process a master file is as follows:

```
Z-SET-TUPLE-p.
    IF Z-EOF-p EQUALS 1 GO TO Z-OPTION-p.
    IF key-1 IN Z-INRECp NOT EQUAL TO
    key-1 IN Z-TUPLE-N GO TO Z-OPTION-p.
    IF key-2 IN Z-INRECp NOT EQUAL TO
    key-2 IN Z-TUPLE-N GO TO Z-OPTION-p.
          !
          !
          !
    IF key-n IN Z-INRECp NOT EQUAL TO
    key-n IN Z-TUPLE-N GO TO Z-OPTION-p.
    MOVE item-a IN Z-INRECp TO item-a
    IN Z-TUPLE-N.
    MOVE item-b IN Z-INRECp TO item-b
    IN Z-TUPLE-N.
          !
          !
          !
    PERFORM Z-READ-p.
    GO TO Z-MOVE-p-EXIT.
Z-OPTION-p.
```

(See Section 33 of this appendix for the code generated.)

```
Z-MOVE-p-EXIT. EXIT.
```

where

p is the number of the master file description in the SUBMODEL subfile.

key-1, key-2, ..., key-n are the key names from the KEYDICT subfile and n is the number of sequence keys as contained in global variable #GNKEY. The keys are in major to minor key order.

item-a, item-b, etc are the names of the non-key fields in the master file record which are required to solve the user's problem, i.e. only those non-key fields whose names appear in both the SUBMODEL and DOMAININDEX subfiles.

When the user's problem uses only one master file the COBOL coding generated simplifies to the following form:

```
Z-SET-TUPLE-DATA-p.
    MOVE item-a IN Z-INRECp TO item-a
    IN Z-TUPLE-N.
    MOVE item-b IN Z-INRECp TO item-b
    IN Z-TUPLE-N.
          !
          !
          !
    PERFORM Z-READ-p.
```

For a non-master file the general form of the COBOL statements generated is as follows:

```
Z-SET-TUPLE-DATA-q.
    IF Z-EOF-q EQUALS 1 GO TO Z-OPTION-q.
Z-MATCH-q.
    IF key-r IN Z-INRECq GREATER THAN
    key-r IN Z-TUPLE-N GO TO Z-OPTION-q.
    IF key-r IN Z-INRECq LESS THAN
    key-r IN Z-TUPLE-N GO TO Z-FETCH-q.
    IF key-s IN Z-INRECq GREATER THAN
    key-s IN Z-TUPLE-N GO TO Z-OPTION-q.
    IF key-s IN Z-INRECq LESS THAN
    key-r IN Z-TUPLE-N GO TO Z-FETCH-q.
          |
          |
          |
    MOVE item-a IN Z-INRECq TO item-a
    IN Z-TUPLE-N.
    MOVE item-b IN Z-INRECq TO item-b
    IN Z-TUPLE-N.
          |
          |
          |
    GO TO Z-MOVE-q-EXIT.
Z-FETCH-q. PERFORM Z-READ-q.
    IF Z-EOF-q EQUALS 0 GO TO Z-MATCH-q.
    CLOSE Z-FILE-q RETAIN OPEN INPUT Z-FILE-q MOVE 0 TO
                                                Z-EOF-q.
    PERFORM Z-READ-q.
Z-OPTION-q.

    (See Section 33 of this appendix for the code
    generated.)

Z-MOVE-q-EXIT. EXIT.
```

where

q is the number of the non-master file description in the SUBMODEL subfile.

key-r, key-s, etc are the names of the key fields used to sequence the non-master file records. The keys are in major to minor key order.

item-a, item-b, etc are the names of the non-key fields in the non-master file record which are required to solve the user's problem, i.e. only those non-key fields whose names appear in both the SUBMODEL and DOMAININDEX subfiles.

33. PARAGRAPH Z-OPTION-i

The COBOL statements generated for the Z-OPTION-i paragraphs, where i denotes the ith file described in the SUBMODEL subfile, depend on the mismatch option selected by the user during the problem specifying dialogue (Section 7.13 of main text). The selected option is indicated by the contents of global variables #GMOP and #GOPT and string variable #S05.

If global variable #GMOP is equal to 'Y' the user wishes a message to be output when a file mismatch condition is detected. In this case the following statements are generated for the Z-OPTION-i paragraph:

```
DISPLAY "relation-name", "error-message",
"KEY VALUES ", key-r
             , key-s

UPON TEST-PRINTER.
```

where

relation-name is the File-name as described in the SUBMODEL subfile,

error-message is the text contained in string variable #S05.

key-r, key-s, etc are the names of the keys used to sequence the file in which the mismatch condition is detected. The keys are listed in major to minor order.

The DISPLAY statement, if generated, is followed by the statements which process the mismatch condition according to the user selected option. If #GOPT is equal to 1 the user wishes to ignore the mismatch condition and continue processing the data files. In this case the following COBOL statement is generated:

```
MOVE 1 TO Z-IGNORE.
```

If global variable #GOPT is equal to 2 the user wishes to create a dummy matching record with numeric non-key items

containing zeros and alphanumeric non-key items containing blanks. To implement this option the following statements are generated:

```
MOVE figurative-constant TO item-a IN Z-TUPLE-N.
MOVE figurative-constant TO item-b IN Z-TUPLE-N.
        ⋮
```

where

item-a, item-b, etc are the names of the non-key fields in the record of the file which are required to solve the user's problem, i.e. only those non-key fields which appear in both the SUBMODEL and DOMAININDEX subfiles.

figurative-constant is ZEROS for a numeric non-key field and SPACES for an alphanumeric non-key field. The field type is determined from the Field description record in the SUBMODEL subfile.

If #GOPT is equal to 3 the user wishes to terminate the processing of the data. This option is implemented by the generation of the following statement:

```
GO TO Z-CLOSE-DOWN.
```

34. END OF PROGRAM

The final statement generated for the COBOL program consists of four asterisks. This statement indicates to the COBOL compiler the end of the source program.

APPENDIX IX

DIALOGUE SAMPLES

APPENDIX IX

DIALOGUE SAMPLES

This appendix contains dialogue samples for the COBOL report program generation system. Sections 1 to 18 show the dialogue carried out with the casual user for the specification of the model problem described in Section 5.9 of the main text. Each stage of the problem specification is shown in a separate section. Sections 19 to 23 contain samples of the dialogue with the data base administrator produced by the catalogue maintenance macros.

N.B. The type face of the teletype on which these listings were produced causes £ to appear as ⌀ and ⌀ to appear as \.

1. STAGE 1

STAGE 1 - INTRODUCTION
THIS SYSTEM IS A SELF-TEACHING COBOL PROGRAM GENERATOR.
BY MEANS OF A QUESTION AND ANSWER DIALOGUE THE SYSTEM WILL ENABLE YOU TO SPECIFY BOTH YOUR PROBLEM AND THE DATA TO BE USED. THE SYSTEM WILL THEN GENERATE A COBOL PROGRAM TO PROVIDE YOU WITH YOUR ANSWERS.
IF AT ANY TIME DURING THE DIALOGUE YOU WISH TO CHANGE YOUR MIND ABOUT AN EARLIER DECISION OR REQUIRE ASSISTANCE PLEASE TYPE %HELP. SHOULD YOU WISH TO ABANDON THE SESSION PLEASE TYPE CTRL A INSTEAD.
IN MANY INSTANCES THE SYSTEM OFFERS YOU A DEFAULT RESPONSE TO A QUESTION. TO TAKE ADVANTAGE OF THIS OPTION YOU MERELY PRESS THE ACCEPT KEY ON YOUR TERMINAL KEYBOARD.
THE SYSTEM TAKES A RELATIONAL VIEW OF THE DATABASE.
THE DATABASE IS A COLLECTION OF STORED DATA AVAILABLE FOR USE IN THE SOLUTION OF A PROBLEM.
THE DATABASE IS MADE UP OF DOMAINS, EACH OF WHICH CONTAINS A SET OF DATA ITEMS RELATING TO A PARTICULAR ATTRIBUTE.
E.G. AN EMPLOYEE-NAME DOMAIN CONTAINS THE SET OF ALL EMPLOYEE NAMES AND

A DEPARTMENT-NO DOMAIN CONTAINS THE SET OF ALL DEPARTMENT NUMBERS.

A DIFFERENT NUMBER OF ITEMS MAY BE PRESENT IN EACH DOMAIN SET.
A RELATION MAY BE DEFINED ON SEVERAL DOMAINS SUCH THAT FOR EVERY ITEM IN ONE DOMAIN OF THE RELATION THERE EXISTS ONE AND ONLY ONE CORRESPONDING ITEM IN EACH OF THE OTHER DOMAINS IN THE RELATION.
E.G. A PERSONNEL RELATION MAY BE DEFINED ON THE DOMAINS EMPLOYEE-NAME, ADDRESS AND DEPARTMENT-NO. THUS EACH EMPLOYEE BELONGS TO ONLY ONE DEPARTMENT AND LIVES AT ONE ADDRESS, ALTHOUGH SEVERAL EMPLOYEES MAY BELONG TO THE SAME DEPARTMENT OR LIVE AT THE SAME ADDRESS.
THE EASIEST WAY TO VISUALISE THE DATA IN A RELATION IS IN TABULAR FORM, WHERE THE DOMAIN NAMES PROVIDE THE COLUMN HEADINGS AND THE ITEMS FROM EACH DOMAIN SET PROVIDE THE ROW ENTRIES.
THUS THE DATA IN THE PERSONNEL RELATION MENTIONED ABOVE COULD BE CONSIDERED AS A TABLE OF WHICH THE FOLLOWING IS AN EXTRACT:-

PERSONNEL RELATION

EMPLOYEE-NAME	ADDRESS	DEPARTMENT-NO
BROWN A.B.	24 HIGH STREET, SOUTHTON	14
BROWN L.M.	24 HIGH STREET, SOUTHTON	02
BLACK C.D.E.	31 MILL LANE, WESTHAM	10
JONES T.	4 CHURCH ROAD, EASTLEY	02
RILEY S.M.	THE CREST, HILL RISE, NORTHAM	06
SCOTT P.J.	7 CASTLE STREET, SOUTHTON	09

THE GENERATED COBOL PROGRAM WILL RETRIEVE YOUR DATA IN SUCH A WAY THAT YOU MAY CONSIDER THE DATA IN THE RELATION TABLE TO BE AVAILABLE ON A ROW BY ROW BASIS, ONE ROW AT A TIME.

2. STAGE 2

```
STAGE 2 - PASSWORD DIALOGUE
ACCESS TO THE SYSTEM DATABASE IS BY MEANS OF A RELATION NAME AND ITS
ASSOCIATED PASSWORD, THE RELATION NAMES AND PASSWORDS ARE ALLOCATED BY
THE DATABASE ADMINISTRATOR TO WHOM AN APPLICATION TO USE THE SYSTEM
SHOULD BE MADE. DATA FROM MORE THAN ONE RELATION MAY BE REQUESTED TO
SOLVE YOUR PROBLEM.
PLEASE TYPE THE NAME OF THE FIRST RELATION WHOSE DATA
YOU WISH TO ACCESS
:←PERSONNEL
PLEASE TYPE THE PASSWORD FOR RELATION PERSONNEL
:←PERS3
HAVE YOU ANY MORE RELATIONS TO ENTER? PLEASE TYPE Y FOR YES OR N
FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NEXT RELATION WHOSE DATA
YOU WISH TO ACCESS
:←STAFF
PLEASE TYPE THE PASSWORD FOR RELATION STAFF
:←STAFF4
HAVE YOU ANY MORE RELATIONS TO ENTER? PLEASE TYPE Y FOR YES OR N
FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NEXT RELATION WHOSE DATA
YOU WISH TO ACCESS
:←DEPARTMENT
PLEASE TYPE THE PASSWORD FOR RELATION DEPARTMENT
:←DEPT4
HAVE YOU ANY MORE RELATIONS TO ENTER? PLEASE TYPE Y FOR YES OR N
FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

3. STAGE 3

STAGE 3 - USERS DATABASE SUBMODEL
THE DOMAINS IN EACH RELATION OF YOUR DATABASE WILL BE SHOWN BELOW TOGETHER WITH DETAILS OF THE SIZE AND TYPE OF THE ITEMS THEY CONTAIN THE SIZE INDICATES THE NUMBER OF CHARACTERS IN EACH ITEM OF THE DOMAIN AND THE TYPE SHOWS IF THEY ARE NUMERIC(N) OR ALPHANUMERIC(A). THE DECIMAL POINT OF A NUMERIC ITEM IS ASSUMED TO BE AFTER THE RIGHT-MOST CHARACTER UNLESS OTHERWISE INDICATED. THE POINT LOCATION SHOWS THE DIRECTION, LEFT(L) OR RIGHT(R), TOGETHER WITH A CHARACTER COUNT RELATIVE TO THE RIGHT-MOST CHARACTER.

E.G. ITEM SIZE	POINT LOCATION	ITEM CONTENTS	NUMERIC VALUE OF CONTENTS
5	L2	17463	174.63
3	R3	468	468000.

WHERE DATA FROM A RELATION IS READILY AVAILABLE IN AN ORDERED SEQUENCE,

THE KEY DOMAINS WHICH DETERMINE THAT SEQUENCE WILL ALSO BE LISTED IN ORDER, STARTING WITH THE MAJOR KEY (KEY NO. 1) AND FINISHING WITH THE MINOR KEY.

RELATION NAME DEPARTMENT
DETAILS OF DOMAINS WITHIN THE RELATION

DOMAIN NAME	ITEM SIZE	TYPE	POINT LOCATION
DEPT-NO	2	N	
DEPT-NAME	20	A	
DEPT-LOC	20	A	
DEPT-MANAGER	20	A	

KEY NO.	KEY DOMAIN NAME
1	DEPT-NO

RELATION NAME PERSONNEL
DETAILS OF DOMAINS IN THE RELATION

DOMAIN NAME	ITEM SIZE	TYPE	POINT LOCATION
EMPLOYEE-NO	4	N	
ADDRESS	40	A	
SEX	1	A	
MARITAL-ST	1	A	
JOIN-YEAR	2	N	
JOIN-MONTH	2	N	
JOIN-DAY	2	N	

KEY NO.	KEY DOMAIN NAME
1	EMPLOYEE-NO

RELATION NAME STAFF
DETAILS OF DOMAINS WITHIN THE RELATION

DOMAIN NAME	ITEM SIZE	TYPE	POINT LOCATION
DEPT-NO	2	N	
EMPLOYEE-NO	4	N	
EMPLOYEE-NAME	20	A	

KEY NO.	DOMAIN NAME
1	DEPT-NO
2	EMPLOYEE-NO

4. STAGE 4

STAGE 4 - SELECTION OF RELEVANT DOMAINS
YOUR DATA BASE CONTAINS A NUMBER OF DOMAINS NOT ALL OF WHICH MAY BE REQUIRED TO SOLVE YOUR CURRENT PROBLEM. THE SYSTEM IS ABOUT TO LIST THE

CONTENTS OF YOUR DATABASE DOMAIN BY DOMAIN; AFTER EACH DOMAIN YOU WILL BE ASKED WHETHER OR NOT THE CURRENT DOMAIN FEATURES IN YOUR PROBLEM.
SHOULD YOU SO DESIRE, THE SYSTEM WILL AUTOMATICALLY ACCUMULATE A TOTAL FOR THE ITEMS RETRIEVED FROM ANY NUMERIC DOMAIN. YOU WILL BE ASKED TO INDICATE IF YOU WISH TO AVAIL YOURSELF OF THIS FEATURE.
ADDRESS
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DEPT-LOC
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DEPT-MANAGER
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DEPT-NAME
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DEPT-NO
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DO YOU WISH TO ACCUMULATE A TOTAL OF RETRIEVED ITEMS IN THIS
DOMAIN? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
EMPLOYEE-NAME
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
EMPLOYEE-NO
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DO YOU WISH TO ACCUMULATE A TOTAL OF RETRIEVED ITEMS IN THIS
DOMAIN? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
JOIN-DAY
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y

```
DO YOU WISH TO ACCUMULATE A TOTAL OF RETRIEVED ITEMS IN THIS
DOMAIN? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
JOIN-MONTH
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DO YOU WISH TO ACCUMULATE A TOTAL OF RETRIEVED ITEMS IN THIS
DOMAIN? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
JOIN-YEAR
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DO YOU WISH TO ACCUMULATE A TOTAL OF RETRIEVED ITEMS IN THIS
DOMAIN? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
MARITAL-ST.
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR
N FOR NO. THE DEFAULT REPLY IS NO.

:←N
SEX
DOES THE ABOVE DOMAIN FEATURE IN YOUR PROBLEM? PLEASE TYPE Y FOR YES OR

N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

5. STAGE 5

```
STAGE 5 - EXTENSION OF DATABASE
ALTHOUGH YOUR DATABASE MAY ONLY BE EXTENTED ON A PERMANENT BASIS IN
CONSULATATION WITH THE DATABASE ADMINISTRATOR, YOU MAY CREATE NEW DATA
ITEMS WHICH ARE AVAILABLE ONLY DURING THIS SYSTEM SESSION.
THE PROCESSING OF THESE TEMPORARY ITEMS WILL BE ENTIRELY UNDER YOUR
CONTROL AND LATER YOU WILL BE GIVEN AN OPPORTUNITY TO SPECIFY YOUR
PROCESSING REQUIREMENTS.
IT IS AT THIS STAGE YOU SHOULD CREATE ANY ITEMS REQUIRED FOR HOLDING
INTERMEDIATE RESULTS OF CALCULATIONS OR FOR REMAINDERS ARISING FROM
ARITHMETIC DIVISIONS.
DO YOU WISH TO CREATE ANY TEMPORARY DATA ITEMS?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
DO YOU WISH TO CREATE ANY TEMPORARY ITEMS WHICH CONTAIN
ALPHANUMERIC DATA?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO CREATE ANY TEMPORARY ITEMS WHICH CONTAIN NUMERIC DATA?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←WORK-ITEM
OF HOW MANY DIGITS DOES WORK-ITEM CONSIST?
THE DEFAULT REPLY IS 18.
:←18
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR WORK-ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL INITIALLY CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←L-O-S-YEARS
OF HOW MANY DIGITS DOES L-O-S-YEARS CONSIST?
THE DEFAULT REPLY IS 18.
:←2
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR L-O-S-YEARS?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL INITIALLY CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
```

```
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←L-O-S-MONTHS
OF HOW MANY DIGITS DOES L-O-S-MONTHS CONSIST?
THE DEFAULT REPLY IS 18.
:←2
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR L-O-S-MONTHS?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL INITIALLY CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE  Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←NO-EMPLOYEES
OF HOW MANY DIGITS DOES NO-EMPLOYEES CONSIST?
THE DEFAULT REPLY IS 18.
:←1
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR NO-EMPLOYEES?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE INITIAL VALUE FOR NO-EMPLOYEES.
THE VALUE MUST CONSIST OF DIGITS AND MAY INCLUDE A DECIMAL POINT, WHICH

MAY NOT BE THE LAST CHARACTER. THE SIGN, IF PRESENT, MUST BE THE FIRST
CHARACTER. BY DEFAULT THE SIGN IS POSITIVE.
:←1
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←AV-SER-YEARS
OF HOW MANY DIGITS DOES AV-SER-YEARS CONSIST?
THE DEFAULT REPLY IS 18.
:←2
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR AV-SER-YEARS?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL INITIALLY CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
```

```
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←AV-SER-MONTHS
OF HOW MANY DIGITS DOES AV-SER-MONTHS CONSIST?
THE DEFAULT REPLY IS 18.
:←2
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN AFTER THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR AV-SER-MONTHS?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE NUMERIC ITEM.
:←MONTHS-SERVICE
OF HOW MANY DIGITS DOES MONTHS-SERVICE CONSIST?
THE DEFAULT REPLY IS 18.
:←3
DO YOU WISH TO SPECIFY A DECIMAL POINT LOCATION OTHER
THAN THE RIGHTMOST DIGIT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
DO YOU WISH TO ENTER AN INITIAL VALUE FOR MONTHS-SERVICE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
BY DEFAULT THE ITEM WILL INITIALLY CONTAIN ZERO.
:←N
DO YOU WISH THE SYSTEM TO ACCUMULATE A TOTAL FOR THIS ITEM?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
HAVE YOU ANY MORE TEMPORARY NUMERIC ITEMS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
YOUR DATABASE MAY ALSO BE TEMPORARILY EXTENDED BY THE INCLUSION OF A
COMPOUND DOMAIN FORMED BY CONCATENATING THE ITEMS FROM TWO OR MORE
OTHER DOMAINS WITHIN THE DATABASE.
E.G. THE TEMPORARY DOMAIN ADDRESS MAY BE COMPOUNDED FROM THE EXISTING
DOMAINS STREET, TOWN AND POSTCODE. COMPOUND DOMAINS ARE ALWAYS OF
ALPHANUMERIC TYPE.
DO YOU WISH TO TEMPORARILY EXTEND YOUR DATABASE BY THE
INCLUSION OF A COMPOUND DOMAIN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE TYPE THE NAME OF THE COMPOUND DOMAIN WHICH YOU WISH TO CREATE.
:←JOIN-DATE
ITEMS FROM THE DOMAINS WHICH YOU ARE ABOUT TO SPECIFY
WILL BE CONCATENATED IN ORDER FROM LEFT TO RIGHT.
PLEASE TYPE THE NAME OF THE FIRST DOMAIN TO BE CONCATENATED
:←JOIN-DAY
PLEASE TYPE THE NAME OF THE NEXT DOMAIN TO BE CONCATENATED
:←JOIN-MONTH
HAVE YOU ANY MORE DOMAINS TO INCLUDE IN THIS CONCATENATION?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
```

```
PLEASE TYPE THE NAME OF THE NEXT DOMAIN TO BE CONCATENATED
:←JOIN-YEAR
HAVE YOU ANY MORE DOMAINS TO INCLUDE IN THIS CONCATENATION?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
COMPOUND DOMAIN JOIN-DATE CONTAINS 6 CHARACTERS AND IS
ALPHANUMERIC IN TYPE.
HAVE YOU ANY MORE DOMAINS TO CREATE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

6. STAGE 6

```
STAGE 6 - DATABASE INCONSISTENCIES
YOUR PROBLEM MAKES USE OF MORE THAN ONE RELATION. IF, WHEN THE RELATIONS

ARE JOINED, A DATA INCONSISTENCY IN A DOMAIN USED AS A SEQUENCE KEY IS
DETECTED BY THE SYSTEM SUCH THAT THERE IS NOT A MATCHING KEY ITEM FOR
ALL RELATIONS, WHICH ONE OF THE FOLLOWING ACTIONS DO YOU WISH THE SYSTEM

TO TAKE?
1    IGNORE THE UNMATCHED ITEMS AND CONTINUE WITH THE NEXT DATA RETRIEVAL

2    CREATE DUMMY MATCHING KEY ITEMS AND CONTINUE PROCESSING ON THE
     ASSUMPTION THAT ALL NUMERIC NON-KEY ITEMS CONTAIN ZEROS AND ALL
     ALPHANUMERIC NON-KEY ITEMS CONTAIN BLANKS.
3    TERMINATE THE PROCESSING OF THE DATABASE.
     ----------------------------------------
PLEASE TYPE 1,2 OR 3, THE DEFAULT REPLY IS 1.
:←1
DO YOU WANT THE SYSTEM TO PRINT A MESSAGE WHEN A MIS-MATCH CONDITION IS

DETECTED? PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

7. STAGE 7

DO YOU WISH TO SELECT ONLY CERTAIN ITEMS FOR RETRIEVAL FROM THE DOMAINS

IN YOUR RELATION(S)?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
-STAGE 7 - SELECTION OF DATA FOR RETRIEVAL
YOU ARE ABOUT TO SPECIFY THE CONDITION(S) WHICH MUST BE SATISFIED BEFORE

THE DATA IS SELECTED FOR RETRIEVAL FROM THE DATA BASE.
CONDITIONS MAY BE SIMPLE OR COMPOUND. A COMPOUND CONDITION IS MADE UP OF

SEVERAL SIMPLE CONDITIONS LINKED BY THE CONJUNCTIONS AND/OR. THE SYSTEM

WILL PROMPT YOU TO BUILD UP COMPOUND CONDITIONS IN TERMS OF SIMPLE
CONDITIONS.
EACH SIMPLE CONDITION CONSISTS OF THREE PARTS:
TWO OPERANDS SEPARATED BY AN OPERATOR.
THE FIRST OPERAND IS THE NAME OF THE DOMAIN TO WHICH THE ITEMS TO BE
TESTED BELONG.
THE SECOND OPERAND SPECIFIES WITH WHAT THE FIRST OPERAND MUST BE
COMPARED. IT MAY BE THE NAME OF A TEMPORARY ITEM, A LITERAL VALUE OR THE

NAME OF THE DOMAIN TO WHICH THE ITEM BEING COMPARED BELONGS.
IF YOU ENTER AN ALPHANUMERIC LITERAL AS THE SECOND OPERAND YOU MUST
ENCLOSE IT IN QUOTATION MARKS, E.G. "ALPHANUMERIC LITERAL".
THE OPERATOR SPECIFIES HOW THE COMPARISON BETWEEN THE FIRST AND SECOND
OPERANDS IS TO BE MADE DURING THE CONDITION TEST.
THE OPERATOR MUST BE ONE OF THE FOLLOWING:

OPERATOR	MEANING
.EQ.	EQUAL TO
.LT.	LESS THAN
.LE.	LESS THAN OR EQUAL TO
.GT.	GREATER THAN
.GE.	GREATER THAN OR EQUAL TO
.NE.	NOT EQUAL TO

THE FULL STOPS ARE AN INTEGRAL PART OF THE OPERATOR
YOU MAY NEGATE ANY OF THE ABOVE OPERATORS BY INCLUDING THE WORD NOT
IMMEDIATELY AFTER THE FIRST FULL STOP.
E.G.
.NOT GT. NOT GREATER THAN
HERE ARE SOME EXAMPLES OF SIMPLE CONDITIONS:
ACCOUNT-NUMBER .LT. TRANSACTION-NO
QTY-ON-HAND .NOT GT. 400
PART-NAME .EQ. "NAILS"
DATA RETRIEVAL
DO YOU WISH TO SPECIFY A COMPOUND CONDITION FOR THE ABOVE TASK?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE TYPE YOUR SIMPLE CONDITION.
:←L-O-S-YEARS .GE. 10

8. STAGE 8

```
STAGE 8 - REPORT LAYOUT INTRODUCTION
PLEASE CHOOSE YOUR PAGE WIDTH. A NARROW PAGE OF 70 CHARACTERS IS
SUITABLE FOR TELETYPE OR VDU OUTPUT. A WIDE PAGE OF 120 CHARACTERS
IS FOR LINE PRINTER OUTPUT. PLEASE TYPE N FOR NARROW OR W FOR WIDE.
THE DEFAULT REPLY IS NARROW.
:←N
PLEASE TYPE THE MAXIMUM NUMBER OF LINES TO BE PRINTED ON A REPORT PAGE
THIS MUST BE A VALUE IN THE RANGE 40 TO 99. THE DEFAULT VALUE IS 60
:←45
WOULD YOU LIKE TO DESIGN THE FORMAT OF THE LINES OF YOUR REPORT OR WOULD

YOU PREFER ONLY TO SPECIFY WHICH ITEMS SHOULD BE INCLUDED IN THE OUTPUT

AND LEAVE THE SYSTEM TO ARRANGE THE EXACT FORMAT OF THE LINE(S)?
IF YOU DESIGN YOUR OWN LAYOUT, YOU MAY INCLUDE TEXT INFORMATION AS WELL

AS DATA ITEMS INCLUDING THE DATE, TIME AND PAGE NUMBER. YOU MAY ALSO
CONTROL THE SPACING OF LINES AND INSERT EDITING CHARACTERS INTO DATA
ITEMS TO IMPROVE THEIR PRESENTATION.
THE SYSTEM WILL ARRANGE THE ITEMS FOR OUTPUT IN THE REQUIRED ORDER
ACROSS THE LINE WITH TWO BLANK SPACES BETWEEN ITEMS. A NEW LINE WILL BE

TAKEN WHEN THERE IS INSUFFICIENT ROOM AT THE END OF A LINE FOR THE
COMPLETE ITEM. ALL OUTPUT ITEMS WILL BE UNEDITED.
DO YOU WISH TO SPECIFY THE FORMAT OF YOUR REPORT? PLEASE TYPE Y FOR YES

OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
YOU WILL SHORTLY BE ASKED TO DESIGN THE LINES WHICH COMPRISE THE TITLES,

HEADINGS AND DETAIL LINES OF YOUR REPORT. TO ASSIST WITH THIS THE NAMES

OF YOUR DATA DOMAINS AND TEMPORARY ITEMS WILL BE DISPLAYED TO YOU ONE AT

A TIME. YOU ARE THEN REQUIRED TO SELECT A ONE CHARACTER LABEL FROM THE
LIST SHOWN BELOW FOR USE LATER WHEN INDICATING THE PRINT POSITIONS OF
THE ITEM IN QUESTION. THE FOLLOWING CHARACTERS ARE VALID LABELS.
A E F G H I J K L N O Q T U V W X Y Z
YOU WILL HAVE NOTICED THAT NOT ALL ALPHABETIC CHARACTERS ARE AVAILABLE
FOR USE AS DATA LABELS. THIS IS BECAUSE SOME OF THEM HAVE SPECIAL
MEANINGS ASSOCIATED WITH EDITING DATA ITEMS PRIOR TO PRINTING. THE
EDITING FACILITIES WILL BE DESCRIBED TO YOU SHORTLY.
WHEN A DATA NAME IS DISPLAYED PLEASE TYPE THE CHARACTER YOU HAVE DECIDED

TO USE AS ITS LABEL. THE DEFAULT REPLY, MADE BY PRESSING THE ACCEPT KEY

ONLY, INDICATES THAT THE DATA DOES NOT APPEAR IN THE OUTPUT REPORT.
AV-SER-MONTHS
:←U
AV-SER-YEARS
:←V
DEPT-MANAGER
:←F
DEPT-NO
:←A
EMPLOYEE-NAME
:←E
```

```
EMPLOYEE-NO
:←N
JOIN-DATE
:←J
JOIN-DAY
:←
JOIN-MONTH
:←
JOIN-YEAR
:←
L-O-S-MONTHS
:←X
L-O-S-YEARS
:←Y
MONTHS-SERVICE
:←
NO-EMPLOYEES
:←T
WORK-ITEM
:←
```

WHEN SPECIFYING THE FORMAT OF A LINE OF THE REPORT, THE PRINT POSITIONS TO BE OCCUPIED BY AN ITEM ARE INDICATED BY TYPING THE LABEL CHARACTER IN THE DESIRED POSITIONS OF THE LINE. BLANK CHARACTERS BEFORE AND BETWEEN ITEMS SHOULD BE INDICATED BY TYPING THE # CHARACTER, BUT BLANK CHARACTERS AT THE RIGHTHAND END OF A LINE MAY BE OMITTED.

E.G. IF K IS THE LABEL ASSIGNED TO PART-CODE-DOMAIN ITEMS AND U IS THE LABEL ASSIGNED TO UNIT-COST DOMAIN ITEMS AND IT IS DESIRED TO PRINT THESE TWO ITEMS IN PRINT POSITIONS 10-16 AND 20-25 RESPECTIVELY, THEN THE REQUIRED FORMAT IS INDICATED BY THE FOLLOWING LINE:

```
#########KKKKKKK###UUUUUU
```

IF MORE PRINT POSITIONS ARE ALLOCATED TO AN ALPHANUMERIC ITEM THAN THE ITEM ACTUALLY REQUIRES, THE ITEM IS LEFT JUSTIFIED IN THE SPECIFIED POSITIONS AND PADDED OUT WITH BLANKS. IF TOO FEW PRINT POSITIONS ARE ALLOCATED TO A DATA ITEM THEN CHARACTERS AT THE RIGHTHAND END WILL BE TRUNCATED.

UNLESS THE EDITING FEATURE TO BE DESCRIBED SHORTLY IS IN USE, THE DECIMAL POINT IN THE OUTPUT FORMAT OF A NUMERIC ITEM IS ASSUMED TO BE AFTER THE RIGHTMOST DIGIT. LEADING ZEROS ARE REPLACED BY BLANKS UP TO BUT NOT INCLUDING A ZERO BEFORE THE IMPLIED DECIMAL POINT. THE DECIMAL POINT LOCATION IN THE ITEM TO BE OUTPUT IS ALIGNED WITH THAT IMPLIED IN THE OUTPUT FORMAT. IF MORE PRINT POSITIONS ARE ALLOCATED THAN THE ITEM REQUIRES, THE UNUSED POSITIONS BEFORE THE DECIMAL POINT WILL BE FILLED WITH BLANKS. IF TOO FEW PRINT POSITIONS ARE ALLOCATED THEN THE HIGH ORDER DIGITS ARE TRUNCATED TO MAKE IT FIT.

9. STAGE 9

STAGE 9 -EDITING
DATA ITEMS MAY BE EDITED PRIOR TO OUTPUT IN THE REPORT IN ORDER TO IMPROVE THE PRESENTATION. THE EDITING OPTIONS AVAILABLE VARY DEPENDING ON WHETHER THE ITEM TO BE EDITED IS ALPHANUMERIC OR NUMERIC.
TWO CHARACTERS ARE AVAILABLE FOR USE WITH ALPHANUMERIC ITEMS AND THEY ARE THE INSERTION CHARACTERS B AND Ø.
INSERTION CHARACTERS MAY BE INSERTED ANYWHERE IN THE STRING OF LABEL CHARACTERS DEFINING THE PRINT POSITIONS OF AN ALPHANUMERIC DATA ITEM. THE Ø CHARACTER WILL PRINT AS A ZERO IN THE OUTPUT LINE, BUT A B CHARACTER WILL BE REPLACED BY A BLANK SPACE.
E.G. IF IT IS DESIRED THAT A 7 CHARACTER PART-CODE ITEM, WHICH HAS BEEN

ASSIGNED THE PRINT LABEL K, SHOULD OCCUPY PRINT POSITIONS 6-14 AND

HAVE A BLANK SPACE BETWEEN THE FIRST AND SECOND CHARACTERS AND A ZERO BETWEEN THE FIFTH AND SIXTH CHARACTERS, THEN THE PRINT-LINE FORMAT SHOULD BE TYPED AS FOLLOWS:

#####KBKKKKØKK

IF THE PART-CODE ITEM CONTAINS THE VALUE "CNUT4DE" THEN THE EDITED VALUE

WILL PRINT AS FOLLOWS:

C NUT4ØDE

WOULD YOU LIKE TO EXPERIMENT WITH THE EFFECT OF USING INSERTION CHARACTERS TO EDIT ALPHANUMERIC DATA ITEMS READY FOR OUTPUT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
THE FOLLOWING MAY BE USED TO EDIT NUMERIC ITEMS PRIOR TO OUTPUT:
$ \ * + - , CR DB B Ø
THE FUNCTION OF EACH OF THE ABOVE EDITING SYMBOLS AND THE COMBINATIONS PERMITTED ARE SET OUT BELOW.
$ AND \ ARE CURRENCY SYMBOLS. A CURRENCY SYMBOL, IF USED, MUST APPEAR AT

THE BEGINNING OF AN OUTPUT FORMAT SPECIFICATION. IT WILL CAUSE THE SELECTED CURRENCY SYMBOL TO PRINT IN FRONT OF THE MOST SIGNIFICANT DIGIT OF THE ITEM BEING EDITED. IT MAY ONLY BE PRECEDED BY A + OR A - CHARACTER.
* IS THE CHEQUE PROTECTION SYMBOL. IF USED, THIS CHARACTER MUST APPEAR AT THE BEGINNING OF AN OUTPUT FORMAT SPECIFICATION. IT WILL CAUSE UNUSED

HIGH ORDER PRINT POSITIONS OF THE ITEM TO BE FILLED WITH *S. ONLY THE + OR - CHARACTER MAY PRECEDE IT.
+ AND - SIGNS. THE SIGN + OR - MAY APPEAR AS THE FIRST CHARACTER OF AN OUTPUT FORMAT SPECIFICATION. IF THE SIGN OF THE ITEM BEING EDITED IS THE

SAME AS THE SIGN CHARACTER IN THE OUTPUT FORMAT THEN THE SIGN WILL PRINT. IF THE ITEM HAS THE OPPOSITE SIGN TO THAT SPECIFIED IN THE OUTPUT

FORMAT, THEN A + WILL BE REPLACED BY A - AND A - WILL BE REPLACED BY A BLANK. THE SIGN CHARACTER WILL BE OUTPUT TO THE LEFT OF THE MOST SIGNIFICANT DIGIT OF THE ITEM PROVIDING A CURRENCY OR CHEQUE PROTECT CHARACTER HAS NOT BEEN SPECIFIED. IF A CURRENCY OR CHEQUE PROTECT SYMBOL

HAS BEEN SPECIFIED THE SIGN WILL REMAIN IN THE LEFT-MOST POSITION OF THE

ITEM.

CR AND DB ARE REPORT SIGNS. EITHER CR OR DB MAY APPEAR IN THE TWO RIGHT-MOST CHARACTERS OF THE OUTPUT FORMAT FOR A NUMERIC ITEM. IF THE ITEM BEING EDITED IS NEGATIVE THEN THE SPECIFIED REPORT SIGN CHARACTERS

WILL PRINT IN THE DESIRED POSITIONS. IF THE ITEM BEING EDITED IS POSITIVE THEN THE TWO PRINT POSITIONS OCCUPIED BY THE REPORT SIGN WILL BE SET TO BLANKS.
B Ø , AND . ARE INSERTION CHARACTERS. THESE CHARACTERS WILL PRINT IN THE DESIGNATED POSITIONS OF THE EDITED ITEM WITH THE EXCEPTION OF THE B

WHICH WILL BE REPLACED BY A BLANK. THE FULL STOP, IF PRESENT, MAY ONLY OCCUR ONCE AS IT REPRESENTS THE DECIMAL POINT LOCATION. THE FULL STOP MAY NOT APPEAR IN THE RIGHT-MOST PRINT POSITION OF AN EDITED ITEM AND MUST BE PRECEDED BY AT LEAST ONE LABEL CHARACTER.
HERE ARE SOME EXAMPLES OF EDITED NUMERIC ITEMS:

EDIT FORMAT	VALUE OF ITEM TO BE EDITED	EDITED RESULT
-$AAA,ØØØ	-23	- $23,ØØØ
*EEEEECR	4795	**4795
FF,FFF.FF	1347.63	1,347.63
GGBGGBGG	27641	2 76 41

WOULD YOU LIKE TO EXPERIMENT WITH THE EFFECT OF EDITING NUMERIC DATA ITEMS READY FOR OUTPUT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:N

10. STAGE 10

STAGE 10 - DETAIL LINE(S) SPECIFICATION
FOR EACH RETRIEVAL FROM THE DATABASE ONE OR MORE DETAIL LINES MAY BE OUTPUT. A DETAIL LINE MAY CONTAIN TEXT AND/OR INCLUDE ANY ITEM FROM THE

CURRENTLY RETRIEVED SET OF DATA AND/OR ANY TEMPORARY ITEM. IF MORE THAN

ONE DETAIL LINE IS TO BE OUTPUT FOR EACH RETRIEVAL, BLANK LINES MAY BE INCLUDED BETWEEN THEM BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED TO ENTER THE NEXT FORMAT LINE. THE FIRST LINE MAY NOT BE BLANK.
ANY LINE OF YOUR REPORT MAY CONTAIN TEXT INFORMATION. IN ORDER TO DISTINGUISH TEXT CHARACTERS FROM LABEL CHARACTERS DENOTING THE PRINT POSITIONS OF DATA ITEMS, THE TEXT IS ENCLOSED IN QUOTATION MARKS. THE QUOTATION MARKS ARE REPLACED BY BLANK CHARACTERS IN THE PRINTED REPORT.

E.G. A DATA ITEM UNIT-PRICE IS ASSIGNED THE PRINT LABEL U AND IS TO BE PRINTED IN PRINT POSITIONS 15-20 TOGETHER WITH THE NAME OF THE ITEM

IN PRINT POSITIONS 2-11. THE OUTPUT FORMAT FOR THE ABOVE LINE SHOULD BE TYPED AS FOLLOWS:
"UNIT PRICE"##$UU.UU
HOW MANY BLANK LINES WOULD YOU LIKE TO APPEAR BETWEEN THE PREVIOUS LINE

OF OUTPUT AND THE FIRST DETAIL LINE OF A RETRIEVAL? PLEASE TYPE A NUMBER

IN THE RANGE 0 TO 3. THE DEFAULT REPLY IS 0.
:←0
PLEASE ENTER THE FORMAT FOR THE FIRST DETAIL LINE.
:←###NNNN#######EEEEEEEEEEEEEEEEEEE###JJBBJJBBJJ##########YY##XX
HAVE YOU ANY MORE DETAIL LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
IF THE DETAIL LINES FROM ONE RETRIEVAL DUPLICATE THOSE FROM AN EARLIER RETRIEVAL DO YOU WISH THE DUPLICATES TO BE IGNORED?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N

11. STAGE 11

STAGE 11 - EXTRA DATA ITEMS - DATE, TIME, PAGE NO.
YOU HAVE ALREADY INDICATED WHICH DATA ITEMS YOU WISH TO OUTPUT IN YOUR DETAIL LINE(S). IN ADDITION THERE ARE THREE OTHERS THAT YOU MAY INCLUDE

IF YOU OPT TO HAVE A REPORT TITLE OR PAGE HEADING. THESE ARE THE DATE AND TIME AT WHICH YOUR REPORT PROGRAM BEGINS TO EXECUTE AND THE REPORT

PAGE NUMBER.
DATE AND TIME EACH OCCUPY 8 PRINT POSITIONS WHILE PAGE NUMBER OCCUPIES 4. THE FOLLOWING STRINGS OF CHARACTERS MUST BE USED TO DENOTE THE PRINT POSITIONS OF THESE SPECIAL ITEMS:

ITEM	PRINT STRING	MEANING
DATE	DD/MM/YY	DD=DAY MM=MONTH YY=YEAR
TIME	HH/MM/SS	HH=HOURS MM=MINUTES SS=SECONDS
PAGE NO.	PPPP	

12. STAGE 12

```
STAGE 12 - REPORT TITLE SPECIFICATION
DO YOU WISH TO HAVE A TITLE PAGE ON YOUR REPORT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
ON WHICH LINE OF THE PAGE WOULD YOU LIKE THE TITLE TO START? PLEASE TYPE

A NUMBER IN THE RANGE 1 TO 22. THE DEFAULT REPLY IS 1.
:←13
THE TITLE MAY CONSIST OF SEVERAL LINES AND INCLUDE THE DATE, TIME AND
PAGE NUMBER ITEMS AS WELL AS TEXT. A BLANK LINE MAY BE INCLUDED IN THE
TITLE BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED TO ENTER ANOTHER
FORMAT LINE. THE FIRST LINE MAY NOT BE BLANK.
PLEASE ENTER THE FORMAT OF THE FIRST LINE OF THE TITLE.
:←################"X.Y.Z. MANUFACTURING COMPANY LIMITED"
HAVE YOU ANY MORE TITLE LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THE TITLE.
:←
HAVE YOU ANY MORE TITLE LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THE TITLE.
:←#########################"LONG SERVICE REPORT"
HAVE YOU ANY MORE TITLE LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THE TITLE.
:←
HAVE YOU ANY MORE TITLE LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THE TITLE.
:←############################"CONFIDENTIAL"
HAVE YOU ANY MORE TITLE LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

13. STAGE 13

STAGE 13 - PAGE HEADING SPECIFICATION
EACH PAGE OF YOUR REPORT MAY HAVE A PAGE HEADING. THE TEXT AT THE TOP OF

EACH REPORT PAGE WILL BE THE SAME, ALTHOUGH IF YOU CHOOSE TO INCLUDE
DATA ITEMS THEIR VALUES MAY VARY FROM PAGE TO PAGE.
AS THE DATA TO BE RETRIEVED IS AVAILABLE IN AN ORDERED SEQUENCE BASED ON.

THE ITEMS IN THE 2 KEY DOMAINS, YOU MAY IN ADDITION TO THE PAGE HEADING

SPECIFY SEQUENCE BREAK HEADINGS.
A DIFFERENT SEQUENCE BREAK HEADING MAY BE SPECIFIED FOR EACH KEY DOMAIN

EXCEPT THE MINOR KEY, WHICH CHANGES WITH EACH RETRIEVAL. THE SEQUENCE
BREAK HEADING WILL PRINT AFTER THE PAGE HEADING AT THE TOP OF EACH PAGE

AND AGAIN LOWER DOWN WHEN A SEQUENCE BREAK IN AN ITEM RETRIEVED FROM A
NON-MINOR KEY DOMAIN IS DETECTED.
AT THE TOP OF THE PAGE ALL THE SEQUENCE BREAK HEADINGS ARE OUTPUT IN
ORDER FROM MAJOR TO PENULTIMATE MINOR KEY SEQUENCE. LOWER DOWN THE
PAGE A SEQUENCE BREAK AT ONE LEVEL WILL CAUSE THAT SEQUENCE BREAK
HEADING TO BE PRINTED AND ALSO THOSE AT LOWER LEVELS, IF ANY.
DO YOU WISH TO SPECIFY A PAGE HEADING FOR EACH PAGE OF YOUR REPORT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
A PAGE HEADING CONSISTS OF ONE OR MORE LINES OF TEXT AND/OR MAY INCLUDE

ANY ITEM FROM A CURRENTLY RETRIEVED SET OF DATA, ANY TEMPORARY ITEM
AND/OR THE DATE, TIME OR PAGE NUMBER ITEMS. A BLANK LINE MAY BE INCLUDED

IN THE PAGE HEADING BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED TO
ENTER ANOTHER FORMAT LINE.
ON WHICH LINE OF THE PAGE WOULD YOU LIKE THE PAGE HEADING TO START?
PLEASE TYPE A NUMBER IN THE RANGE 1 TO 10. THE DEFAULT REPLY IS 1.
:←3
THE FIRST LINE MAY NOT BE BLANK.
PLEASE ENTER THE FORMAT OF THE FIRST LINE OF THE PAGE HEADING.
:←"LONG SERVICE REPORT FOR THE YEAR ENDING 31ST DECEMBER 1977 PAGE"PPPP

HAVE YOU ANY MORE PAGE HEADING LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF PAGE HEADING.
:←
HAVE YOU ANY MORE PAGE HEADING LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N

14. STAGE 14

```
STAGE 14 - SEQUENCE BREAK HEADING SPECIFICATION
DO YOU WISH TO SPECIFY SEQUENCE BREAK HEADINGS IN YOUR REPORT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
A SEQUENCE BREAK HEADING CONSISTS OF ONE OR MORE LINES OF TEXT AND/OR
MAY INCLUDE ANY ITEM FROM A CURRENTLY RETRIEVED SET OF DATA OR ANY
TEMPORARY ITEM. A BLANK LINE MAY BE INCLUDED IN THE SEQUENCE BREAK
HEADING BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED TO ENTER ANOTHER
FORMAT LINE.
SEQUENCE BREAK HEADING FOR KEY DOMAIN DEPT-NO
HOW MANY BLANK LINES WOULD YOU LIKE TO APPEAR BETWEEN THE PREVIOUS LINE

OF OUTPUT AND THE FIRST LINE OF THIS HEADING? PLEASE TYPE A NUMBER IN
THE RANGE 0 TO 3. THE DEFAULT REPLY IS 0.
:←1
THE FIRST LINE MAY NOT BE BLANK.
PLEASE ENTER THE FORMAT OF THE FIRST LINE OF THIS HEADING.
:←"DEPARTMENT NO."AA" DEPARTMENT MANAGER "FFFFFFFFFFFFFFFFFFFF
HAVE YOU ANY MORE LINES TO ENTER FOR THIS HEADING?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THIS HEADING.
:←
HAVE YOU ANY MORE LINES TO ENTER FOR THIS HEADING?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THIS HEADING.
:←"EMPLOYEE NO. EMPLOYEE NAME          DATE OF JOINING LENGTH OF SERVICE"

HAVE YOU ANY MORE LINES TO ENTER FOR THIS HEADING?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THIS HEADING.

:←##################################"DAY MONTH YEAR"#####"YEARS MONTHS"

HAVE YOU ANY MORE LINES TO ENTER FOR THIS HEADING?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THIS HEADING.
:←
HAVE YOU ANY MORE LINES TO ENTER FOR THIS HEADING?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

15. STAGE 15

```
STAGE 15 - SUB-TOTAL LINE(S) SPECIFICATION
YOU HAVE ASKED FOR THE TOTALS OF CERTAIN NUMERIC ITEMS TO BE ACCUMULATED

DURING THE PROCESSING OF YOUR DATA. SHORTLY YOU WILL BE ASKED TO SPECIFY

THE FORMAT IN WHICH THESE TOTALS ARE TO BE OUTPUT AT THE END OF YOUR
REPORT.
MEANWHILE, AS THE DATA IS RETRIEVED IN AN ORDERED SEQUENCE, YOU MAY ASK

FOR SUB-TOTALS TO BE OUTPUT WHEN A SEQUENCE CHANGE IS DETECTED IN THE
DATA RETRIEVED FROM ANY KEY DOMAIN EXCEPT THE MINOR KEY, WHICH CHANGES
WITH EACH RETRIEVAL.
SUB-TOTALS ARE OUTPUT IN ORDER FROM PENULTIMATE MINOR TO MAJOR KEY
SEQUENCE. A SEQUENCE CHANGE AT AN INTERMEDIATE LEVEL WILL CAUSE THE
SUB-TOTALS FOR THAT KEY AND FOR ALL THE KEYS MINOR TO IT TO BE OUTPUT AS

WELL.
DO YOU WISH TO SPECIFY SEQUENCE BREAK SUB-TOTALS IN YOUR REPORT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
A SEQUENCE BREAK SUB-TOTAL CONSISTS OF ONE OR MORE LINES OF TEXT AND/OR

MAY INCLUDE ANY NON-ACCUMULATED ITEM, EITHER TEMPORARY OR FROM THE
PREVIOUS SET OF RETRIEVED DATA, AS WELL AS THE SUB-TOTALS OF THE ITEMS
WHICH HAVE BEEN ACCUMULATED. A BLANK LINE MAY BE INCLUDED IN A
SEQUENCE BREAK SUB-TOTAL BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED
TO ENTER ANOTHER FORMAT LINE.
SUB-TOTAL OUTPUT FOR A SEQUENCE BREAK IN KEY DOMAIN DEPT-NO
HOW MANY BLANK LINES WOULD YOU LIKE TO APPEAR BETWEEN THE PREVIOUS LINE

OF OUTPUT AND THE FIRST LINE OF THE SUB-TOTAL? PLEASE TYPE A NUMBER IN
THE RANGE Ø TO 3. THE DEFAULT REPLY IS Ø.
:←1
THE FIRST LINE MAY NOT BE BLANK.
PLEASE ENTER THE FORMAT OF THE FIRST LINE OF THIS SUB-TOTAL OUTPUT.
:←"DEPARTMENT NO."AA" NO. OF EMPLOYEES"TTTT"  AVERAGE SERVICE"VV##UU
HAVE YOU ANY MORE LINES TO ENTER FOR THIS SUB-TOTAL OUTPUT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT LINE OF THIS SUB-TOTAL OUTPUT.
:←
HAVE YOU ANY MORE LINES TO ENTER FOR THIS SUB-TOTAL OUTPUT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

16. STAGE 16

```
STAGE 16 - TOTAL LINE(S) SPECIFICATION
THE ACCUMULATED TOTALS OUTPUT CONSISTS OF ONE OR MORE LINES OF TEXT
AND/OR MAY INCLUDE ANY NON-ACCUMULATED ITEM FROM THE PREVIOUS SET OF
RETRIEVED DATA OR ANY TEMPORARY ITEM AS WELL AS THE TOTALS OF THE ITEMS

WHICH HAVE BEEN ACCUMULATED. A BLANK LINE MAY BE INCLUDED IN THE TOTALS

BY PRESSING ONLY THE ACCEPT KEY WHEN PROMPTED TO ENTER ANOTHER FORMAT
LINE.
DO YOU WISH TO SPECIFY TOTALS OUTPUT IN YOUR REPORT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
HOW MANY BLANK LINES WOULD YOU LIKE TO APPEAR BETWEEN THE PREVIOUS LINE

OF OUTPUT AND THE FIRST LINE OF TOTALS? PLEASE TYPE A NUMBER IN THE
RANGE Ø TO 3. THE DEFAULT REPLY IS Ø.
:←1
THE FIRST LINE MAY NOT BE BLANK
PLEASE ENTER THE FORMAT OF THE FIRST TOTAL LINE.
:←"COMPANY TOTAL "TTTT"EMPLOYEES"
HAVE YOU ANY MORE TOTAL LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
PLEASE ENTER THE FORMAT OF THE NEXT TOTAL LINE.
:←"AVERAGE LENGTH OF SERVICE   "VV"YEARS"UU"MONTHS"
HAVE YOU ANY MORE TOTAL LINES TO ENTER?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

17. STAGE 17

```
STAGE 17 - VIEW OF SAMPLE REPORT PAGE
YOU ARE ABOUT TO BE OFFERED THE OPPORTUNITY OF SEEING A SAMPLE OF A PAGE

OF YOUR REPORT. THE SAMPLE PAGE WILL SHOW YOU THE ARRANGEMENT OF THE
VARIOUS LINES WHOSE FORMAT YOU HAVE JUST SPECIFIED, BUT WILL NOT PROVIDE

ACTUAL VALUES FOR DATA ITEMS.
WOULD YOU LIKE TO SEE A SAMPLE OF AN OUTPUT PAGE?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:-Y
```

X.Y.Z. MANUFACTURING COMPANY LIMITED

LONG SERVICE REPORT

CONFIDENTIAL

```
LONG SERVICE REPORT FOR THE YEAR ENDING 31ST DECEMBER 1977 PAGE PPPP

DEPARTMENT NO. AA  DEPARTMENT MANAGER  FFFFFFFFFFFFFFFFFFFF

EMPLOYEE NO. EMPLOYEE NAME          DATE OF JOINING      LENGTH OF SERVICE
                                    DAY MONTH YEAR       YEARS MONTHS

  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX
  NNNN       EEEEEEEEEEEEEEEEEEEE   JJ   JJ   JJ          YY    XX

DEPARTMENT NO. AA  NO. OF EMPLOYEES TTTT   AVERAGE SERVICE VV  UU


COMPANY TOTAL  TTTT EMPLOYEES
AVERAGE LENGTH OF SERVICE    VV YEARS UU MONTHS
ARE YOU SATISFIED WITH THE PAGE LAYOUT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
```

18. STAGE 18

STAGE 18 - OWN CODE PROCESSING
YOU ARE ABOUT TO BE GIVEN THE OPPORTUNITY OF SUPPLEMENTING THE STANDARD

SYSTEM PROCESSING OF YOUR DATA BY SPECIFYING YOUR OWN CALCULATIONS AND/OR DATA MOVEMENTS. THESE SHOULD INCLUDE THE PROCESSING OF TEMPORARY

ITEMS.
THE OPTION TO SPECIFY YOUR OWN SUPPLEMENTARY PROCESSING WILL BE AVAILABLE AT THE FOLLOWING POINTS DURING THE EXECUTION OF THE COBOL PROGRAM:

AT THE START OF PROCESSING BEFORE ANY DATA IS RETRIEVED,
IMMEDIATELY AFTER A DATA RETRIEVAL,
AT A SEQUENCE BREAK ON A SPECIFIC NON-MINOR KEY DOMAIN ITEM,
PRIOR TO PRINTING ANY GROUP OF HEADING, DETAIL, SUB-TOTAL OR TOTAL

LINES.

DO YOU WISH TO TAKE ADVANTAGE OF THE ABOVE FACILITIES?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
FOUR ARITHMETIC STATEMENTS ARE AVAILABLE FOR USE IN YOUR OWN CALCULATIONS, ONE FOR EACH OF THE ARITHMETIC OPERATIONS:
ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION.
EACH STATEMENT REQUIRES THREE OPERANDS AND TAKES THE FOLLOWING FORM:
ADD OPERAND-1, OPERAND-2 GIVING OPERAND-3
SUBTRACT OPERAND-1 FROM OPERAND-2 GIVING OPERAND-3
MULTIPLY OPERAND-1 BY OPERAND-2 GIVING OPERAND-3
DIVIDE OPERAND-1 BY OPERAND-2 GIVING OPERAND-3
THE DIVISION REMAINDER MAY, IF DESIRED, BE SAVED IN A NAMED DOMAIN OR TEMPORARY ITEM.
OPERAND-3 MAY BE THE NAME OF ANY TEMPORARY ITEM OR THE NAME OF A DOMAIN

TO WHICH THE ITEM BEING CALCULATED BELONGS.
OPERAND-1 AND OPERAND-2 MAY BE EITHER A NUMERIC LITERAL, THE NAME OF A TEMPORARY ITEM OR THE NAME OF A DOMAIN TO WHICH THE ITEM BEING CALCULATED BELONGS.
E.G MULTIPLY QUANTITY BY PRICE GIVING COST
DIVIDE PENCE BY 100 GIVING POUNDS
ONE DATA MOVEMENT STATEMENT IS AVAILABLE FOR YOUR OWN DATA MOVEMENTS.
THIS STATEMENT REQUIRES TWO OPERANDS AND HAS THE FOLLOWING FORM:
MOVE OPERAND-1 TO OPERAND-2
OPERAND-2 IS THE RECEIVING ITEM AND MAY BE THE NAME OF A TEMPORARY ITEM

OR THE NAME OF A DOMAIN TO WHICH THE RECEIVING ITEM BELONGS.
OPERAND-1 IS THE SOURCE ITEM AND MAY BE A LITERAL, A TEMPORARY ITEM OR THE NAME OF A DOMAIN TO WHICH THE ITEM BEING MOVED BELONGS.
OPERAND-1 AND OPERAND-2 MUST BE OF THE SAME TYPE, EITHER BOTH NUMERIC OR

BOTH ALPHANUMERIC.
E.G. MOVE "NOT MARRIED" TO SPOUSE-NAME
MOVE QTY-ON-ORDER TO QTY-ON-HAND
MOVE 1.65 TO UNIT-PRICE
WHEN ALPHANUMERIC DATA IS MOVED THE CHARACTERS FROM THE SOURCE ITEM ARE TRANSFERRED TO THE CORRESPONDING POSITIONS OF THE RECEIVING ITEM, STARTING WITH THE LEFT-MOST. IF THE RECEIVING ITEM IS THE SHORTER OF THE

TWO ITEMS THEN EXCESS CHARACTERS FROM THE SOURCE ITEM ARE IGNORED.
IF THE RECEIVING ITEM IS THE LONGER THE EXCESS CHARACTERS ARE FILLED WITH BLANKS.

WHEN NUMERIC DATA IS MOVED THE DECIMAL POINTS IN THE SOURCE ITEM AND RECEIVING ITEM ARE ALIGNED. IF THERE ARE FEWER DIGITS BEFORE OR AFTER THE DECIMAL POINT IN THE RECEIVING ITEM THEN THE EXCESS DIGITS ARE TRUNCATED. IF THERE ARE MORE DIGITS BEFORE OR AFTER THE DECIMAL POINT IN

THE RECEIVING ITEM THEN THE EXCESS POSITIONS ARE SET TO CONTAIN ZERO.
AS YOU HAVE TAKEN ADVANTAGE OF THE SYSTEMS ACCUMULATED TOTALS OPTION YOU

MAY, DURING YOUR OWN PROCESSING, HAVE ACCESS TO THE TOTALS APPLICABLE AT A SPECIFIC KEY SEQUENCE BREAK OR AFTER ALL THE DATA HAS BEEN RETRIEVED.
IN ORDER TO DISTINGUISH THE TOTALS OF ITEMS FROM A GIVEN DOMAIN FROM THE PREVIOUSLY RETRIEVED ITEM FROM THE SAME DOMAIN, THE DOMAIN NAME IS IMMEDIATELY PRECEDED BY AN * CHARACTER WHEN THE TOTAL IS REQUIRED.
E.G. A RELATION CONTAINS ITEMS FROM NUMERIC DOMAINS CALLED STOCK-VALUE AND QUANTITY AND IS SEQUENCED ON ITEMS IN KEY DOMAINS CALLED PART-CLASS AND PART-NO. IF THE ACCUMULATED TOTALS OPTION HAS BEEN REQUESTED FOR THE STOCK-VALUE AND QUANTITY ITEMS, THEN A TEMPORARY

ITEM CALLED AVERAGE-PRICE MAY BE CALCULATED EACH TIME A SEQUENCE CHANGE OCCURS IN THE PART-CLASS KEY ITEM OF THE RETRIEVED DATA BY THE FOLLOWING OWN CODE STATEMENT:
DIVIDE *STOCK-VALUE BY *QUANTITY GIVING AVERAGE-PRICE
N.B. THIS SPECIAL TOTAL FORM OF A DATA NAME MAY NOT BE USED AS OPERAND-3

IN THE ARITHMETIC STATEMENTS NOR AS OPERAND-2 IN A MOVE STATEMENT.

BEFORE ENTERING ANY OWN CODE STATEMENTS YOU WILL BE GIVEN THE OPPORTUNITY TO SPECIFY WHAT CONDITIONS, IF ANY, MUST BE SATISFIED BEFORE

THE STATEMENT IS OBEYED.
N.B. THE OWN CODE STATEMENTS AT EACH PROCESSING POINT ARE OBEYED IN THE

ORDER IN WHICH YOU ENTER THEM.
WOULD YOU LIKE TO BE REMINDED OF HOW TO SPECIFY A CONDITION?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
AT THE START OF PROCESSING BEFORE ANY DATA IS RETRIEVED
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
IMMEDIATELY AFTER A DATA RETRIEVAL
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←SUBTRACT JOIN-YEAR FROM 77 GIVING WORK-ITEM
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←MULTIPLY WORK-ITEM BY 1.2 GIVING MONTHS-SERVICE

```
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←SUBTRACT JOIN-MONTH FROM 13 GIVING WORK-ITEM
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←ADD WORK-ITEM, MONTHS-SERVICE GIVING MONTHS-SERVICE
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←DIVIDE MONTHS-SERVICE BY 12 GIVING L-O-S-YEARS
IF YOU WISH TO SAVE THE REMAINDER PLEASE TYPE THE NAME OF THE DOMAIN OR

TEMPORARY ITEM WHERE IT IS TO BE STORED. BY DEFAULT THE REMAINDER WILL
NOT BE SAVED.
:←L-O-S-MONTHS
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
AT A SEQUENCE BREAK IN THE DEPT-NO KEY DOMAIN ITEM
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PRIOR TO PRINTING A PAGE HEADING
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PRIOR TO PRINTING THE DEPT-NO SEQUENCE BREAK HEADING
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PRIOR TO PRINTING THE DETAIL LINE(S)
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PRIOR TO PRINTING THE DEPT-NO SUBTOTALS
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
```

```
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←DIVIDE *MONTHS-SERVICE BY *NO-EMPLOYEES GIVING WORK-ITEM
IF YOU WISH TO SAVE THE REMAINDER PLEASE TYPE THE NAME OF THE DOMAIN OR

TEMPORARY ITEM WHERE IT IS TO BE STORED. BY DEFAULT THE REMAINDER WILL
NOT BE SAVED.
:←
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←DIVIDE WORK-ITEM BY 12 GIVING AV-SER-YEARS
IF YOU WISH TO SAVE THE REMAINDER PLEASE TYPE THE NAME OF THE DOMAIN OR

TEMPORARY ITEM WHERE IT IS TO BE STORED. BY DEFAULT THE REMAINDER WILL
NOT BE SAVED.
:←AV-SER-MONTHS
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PRIOR TO PRINTING THE TOTAL LINE(S)
HAVE YOU ANY OWN CODE PROCESSING TO SPECIFY FOR THE ABOVE POINT DURING
THE DATA PROCESSING RUN?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←DIVIDE *MONTHS-SERVICE BY *NO-EMPLOYEES GIVING WORK-ITEM
IF YOU WISH TO SAVE THE REMAINDER PLEASE TYPE THE NAME OF THE DOMAIN OR

TEMPORARY ITEM WHERE IT IS TO BE STORED. BY DEFAULT THE REMAINDER WILL
NOT BE SAVED.
:←
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←Y
IS THE OWN CODE STATEMENT THAT YOU ARE ABOUT TO ENTER CONDITIONAL?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
PLEASE ENTER YOUR OWN CODE STATEMENT.
:←DIVIDE WORK-ITEM BY 12 GIVING AV-SER-YEARS
IF YOU WISH TO SAVE THE REMAINDER PLEASE TYPE THE NAME OF THE DOMAIN OR

TEMPORARY ITEM WHERE IT IS TO BE STORED. BY DEFAULT THE REMAINDER WILL
NOT BE SAVED.
:←AV-SER-MONTHS
HAVE YOU ANY MORE OWN CODE STATEMENTS TO ENTER AT THE ABOVE POINT?
PLEASE TYPE Y FOR YES OR N FOR NO. THE DEFAULT REPLY IS NO.
:←N
YOU HAVE NOW FULLY SPECIFIED YOUR DATA AND YOUR PROBLEM AND THE SYSTEM
IS READY TO GENERATE THE COBOL PROGRAM WHICH WILL PROVIDE YOU WITH YOUR

ANSWERS.
```

IF YOU HAVE ANY COMMENTS ABOUT ANY ASPECT OF THIS SYSTEM PLEASE ENTER THEM LINE BY LINE AS YOU RECEIVE THE INVITATION TO TYPE. A BLANK RESPONSE WILL BE TAKEN TO INDICATE THE END OF YOUR COMMENTS.
:←
END OF SESSION, GOODBYE. PLEASE TYPE %FINISH TO EXIT FROM THE SYSTEM.
:←%FINISH

19. CREATE CATALOGUE

```
CATALOGUE CREATION MACRO.
THIS MACSO CREATES AN EMPTY CATALOGUE AND ESTABLISHES THE SECURITY
SYSTEM FOR PROTECTING ACCESS TO THE FILE DESCRIPTIONS WHICH THE
CATALOGUE WILL EVENTUALLY CONTAIN.
PLEASE TYPE THE PASSWORD TO BE USED BY PERSONS ENTITLED TO AMEND THE
CATALOGUE. THE PASSWORD MAY BE UP TO 8 CHARACTERS LONG AND THE DEFAULT

VALUE IS BLANK. CHARACTERS IN EXCESS OF 8 WILL BE IGNORED.
:←CATPSWD
PLEASE TYPE THE NUMBER OF SECURITY LEVELS BY WHICH ACCESS TO FILE DATA
IS TO BE PROTECTED. THE NUMBER MUST BE GREATER THAN ZERO AND LESS THAN
13. THE DEFAULT REPLY IS 12.
:←4Q
4Q INVALID SECURITY LEVEL. PLEASE ENTER CORRECT VALUE.
:←4
EMPTY CATALOGUE WITH 4 SECURITY LEVELS CREATED ON
21/12/78 AT 14/53/24 AND READY FOR USE.
```

Catalogue Control Record

```
0,1,CATPSWD,4,21/12/78,14/53/24,
```

20. CHANGE CATALOGUE PASSWORD

```
MACRO TO CHANGE CATALOGUE PASSWORD.
PLEASE TYPE THE OLD PASSWORD.
:←CATPWORD
CATPWORD IS AN INVALID PASSWORD. TASK ABANDONED.
```

```
MACRO TO CHANGE CATALOGUE PASSWORD.
PLEASE TYPE THE OLD PASSWORD.
:←CATPAWD
PLEASE TYPE THE NEW PASSWORD OF UP TO 8 CHARACTERS.
:←CATAPASS
NEW PASSWORD IN OPERATION ON 27/12/78 AT 15/20/35.
```

21. LIBRARIAN

```
CATALOGUE LIBRARIAN.
THIS MACRO UPDATES THE DATABASE CATALOGUE OF FILE DESCRIPTIONS.
PLEASE TYPE THE CATALOGUE PASSWORD
:←KATAPASS
KATAPASS IS AN INVALID PASSWORD. RUN TERMINATED.
```

```
CATALOGUE LIBRARIAN.
THIS MACRO UPDATES THE DATABASE CATALOGUE OF FILE DESCRIPTIONS.
PLEASE ENTER THE CATALOGUE PASSWORD
:←CATAPASS
```

22. LIBPRELIM AND LIBDELETE

```
DO YOU WISH TO ADD A NEW FILE DESCRIPTION OR DELETE AN EXISTING ONE?
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←DELEET
DELEET IS AN INVALID RESPONSE
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←DELETE
PLEASE TYPE THE NAME OF THE FILE WHOSE DESCRIPTION YOU WISH TO DELETE.
:←STAFF
PLEASE TYPE PASSWORD FOR TOP SECURITY LEVEL FOR FILE
STAFF
:←STAFPASS
STAFPASS IS NOT AN ACCEPTABLE PASSWORD. REQUEST CANCELLED.
DO YOU WISH TO ADD A NEW FILE DESCRIPTION OR DELETE AN EXISTING ONE?
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←DELETE
PLEASE TYPE THE NAME OF THE FILE WHOSE DESCRIPTION YOU WISH TO DELETE.
:←STAFF
PLEASE TYPE PASSWORD FOR TOP SECURITY LEVEL FOR FILE
STAFF
:←STAFF1
CATALOGUE UPDATED ON 21/11/78 AT 19/51/19
DO YOU WISH TO ADD A NEW FILE DESCRIPTION OR DELETE AN EXISTING ONE?
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←FINISH
```

23. LIBPRELIM AND LIBADD

```
DO YOU WISH TO ADD A NEW FILE DESCRIPTION OR DELETE AN EXISTING ONE?
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←ADD
PLEASE TYPE THE NAME OF THE FILE WHOSE DESCRIPTION YOU
WISH TO ADD.
:←DEPARTMENT
PLEASE TYPE PASSWORD FOR TOP SECURITY LEVEL FOR FILE
DEPARTMENT
:←DEPT1
PLEASE TYPE THE NUMBER OF FIELDS IN A RECORD OF FILE
:←4
PLEASE TYPE THE PASSWORD FOR SECURITY LEVEL 2
:←DEPT2
PLEASE TYPE THE PASSWORD FOR SECURITY LEVEL 3
:←DEPT3
PLEASE TYPE THE PASSWORD FOR SECURITY LEVEL 4
:←DEPT4
PLEASE TYPE UP TO 70 CHARACTERS OF DESCRIPTION ABOUT FILE
:←DEPARTMENT DESCRIPTION RELATION
ON WHICH STORAGE MEDIUM IS THIS FILE?
PLEASE TYPE 2 CHARACTERS. MT FOR MAGNETIC TAPE
CR FOR PUNCHED CARDS. PT FOR PAPER TAPE
ED FOR EXCHANGEABLE DISC STORE
:←MT
PLEASE ENTER BLOCKSIZE
:←396
PLEASE TYPE MAXIMUM NO. OF CHARACTERS IN A RECORD
:←66
PLEASE TYPE THE FILE LABEL WHICH MAY BE UP TO 12
CHARACTERS LONG. EXCESS CHARACTERS WILL BE IGNORED.
:←DEPARTMENT
PLEASE TYPE NO. OF SEQUENCE KEY FIELDS
:←1
YOU ARE ABOUT TO BE ASKED FOR DETAILS OF FIELDS WITHIN A RECORD
WHERE POSSIBLE PLEASE ENTER FIELD NAMES IN ASCENDING START POSITION
AS THIS MAKES FOR MORE EFFICIENT PROCESSING
PLEASE TYPE THE NAME OF FIELD NO. 1
:←DEPT-NO
WHICH SECURITY LEVEL DO YOU WISH TO ASSIGN TO DEPT-NO?
PLEASE TYPE A NUMBER IN THE RANGE 1 TO 4.  1=HIGHEST LEVEL
4 = LOWEST LEVEL
:←4
IN WHICH CHARACTER POSITION DOES THE FIELD START?
1 IS THE FIRST CHARACTER POSITION IN THE RECORD
:←5
HOW MANY CHARACTER POSITIONS DOES THE FIELD OCCUPY?
:←2
DOES THIS FIELD CONTAIN NUMERIC OR ALPHANUMERIC DATA?
PLEASE TYPE N FOR NUMERIC OR A FOR ALPHANUMERIC
:←N
PLEASE TYPE THE POSITION OF THE DECIMAL POINT
RELATIVE TO THE RIGHTHAND CHARACTER OF THE FIELD
TYPE L FOR LEFT OR R FOR RIGHT FOLLOWED BY AN UNSIGNED INTEGER
:←L0
```

```
PLEASE TYPE FIELD KEY NO. IN THE RANGE Ø TO 9
Ø DENOTES A NON-KEY FIELD, 1 DENOTES THE MAJOR KEY
:←1
PLEASE INDICATE SEQUENCE ORDER. TYPE A FOR ASCENDING OR
D FOR DESCENDING
:←A
PLEASE TYPE UP TO 7Ø CHARACTERS OF DESCRIPTION ABOUT THE FIELD
:←DEPARTMENT NUMBER
PLEASE TYPE THE NAME OF FIELD NO. 2
:←DEPT-NAME
WHICH SECURITY LEVEL DO YOU WISH TO ASSIGN TO DEPT-NAME?
PLEASE TYPE A NUMBER IN THE RANGE 1 TO 4.  1=HIGHEST LEVEL
4 = LOWEST LEVEL
:←4
IN WHICH CHARACTER POSITION DOES THE FIELD START?
1 IS THE FIRST CHARACTER POSITION IN THE RECORD
:←7
HOW MANY CHARACTER POSITIONS DOES THE FIELD OCCUPY?
:←2Ø
DOES THIS FIELD CONTAIN NUMERIC OR ALPHANUMERIC DATA?
PLEASE TYPE N FOR NUMERIC OR A FOR ALPHANUMERIC
:←A
PLEASE TYPE KEY NO. IN THE RANGE Ø TO 9
Ø DENOTES A NON-KEY FIELD, 1 DENOTES THE MAJOR KEY
:←Ø
CAN FIELD BE TREATED AS A DOMAIN?. TYPE Y FOR YES OR N FOR NO
:←Y
PLEASE TYPE UP TO 7Ø CHARACTERS OF DESCRIPTION ABOUT FIELD
:←DEPARTMENT NAME
PLEASE TYPE THE NAME OF FIELD NO. 3
:←DEPT-LOC
WHICH SECURITY LEVEL DO YOU WISH TO ASSIGN TO DEPT-LOC?
PLEASE TYPE A NUMBER IN THE RANGE 1 TO 4.  1=HIGHEST LEVEL
4 = LOWEST LEVEL
:←4
IN WHICH CHARACTER POSITION DOES THE FIELD START?
1 IS THE FIRST CHARACTER POSITION IN THE RECORD
:←27
HOW MANY CHARACTER POSITIONS DOES THE FIELD OCCUPY?
:←2Ø
DOES THIS FIELD CONTAIN NUMERIC OR ALPHANUMERIC DATA?
PLEASE TYPE N FOR NUMERIC OR A FOR ALPHANUMERIC
:←A
PLEASE TYPE FIELD KEY NO. IN THE RANGE Ø TO 9
Ø DENOTES A NON-KEY FIELD, 1 DENOTES THE MAJOR KEY
:←Ø
CAN FIELD BE TREATED AS A DOMAIN? TYPE Y FOR YES OR N FOR NO
:←N
PLEASE TYPE UP TO 7Ø CHARACTERS OF DESCRIPTION ABOUT THE FIELD
:←DEPARTMENT LOCATION
PLEASE TYPE THE NAME OF FIELD NO. 4
:←DEPT-MANAGER
WHICH SECURITY LEVEL DO YOU WISH TO ASSIGN TO DEPT-MANAGER?
PLEASE TYPE A NUMBER IN THE RANGE 1 TO 4.  1=HIGHEST LEVEL
4 = LOWEST LEVEL
:←4
```

```
IN WHICH CHARACTER POSITION DOES THE FIELD START?
1 IS THE FIRST CHARACTER POSITION IN THE RECORD
:←47
HOW MANY CHARACTER POSITIONS DOES THE FIELD OCCUPY?
:←20
DOES THIS FIELD CONTAIN NUMERIC OR ALPHANUMERIC DATA?
PLEASE TYPE N FOR NUMERIC OR A FOR ALPHANUMERIC
:←A
PLEASE TYPE FIELD KEY NO. IN THE RANGE 0 TO 9
0 DENOTES A NON-KEY FIELD, 1 DENOTES THE MAJOR KEY
:←0
CAN FIELD BE TREATED AS A DOMAIN?. TYPE Y FOR YES OR N FOR NO
:←Y
PLEASE TYPE UP TO 70 CHARACTERS OF DESCRIPTION ABOUT THE FIELD
:←DEPARTMENT MANAGER
CATALOGUE UPDATED ON 21/02/78 AT 20/17/44
DO YOU WISH TO ADD A NEW FILE DESCRIPTION OR DELETE AN EXISTING ONE?
PLEASE TYPE ADD OR DELETE, AT END TYPE FINISH.
:←FINISH
```

Contents of Catalogue

```
1,12,CATAPASS,4,21/02/79,20/17/44,
DEPARTMENT,4,DEPT1    ,DEPT2    ,DEPT3    ,DEPT4    ,
DEPARTMENT DESCRIPTION RELATION
MT,396,66,DEPARTMENT  ,S,,,1,
DEPT-NO,4,5,2,N,L0,1,A,,
DEPARTMENT NUMBER
DEPT-NAME,4,7,20,A,,0,,Y,
DEPARTMENT NAME
DEPT-LOC,4,27,20,A,,0,,N,
DEPARTMENT LOCATION
DEPT-MANAGER,4,47,20,A,,0,,Y,
DEPARTMENT MANAGER
```

APPENDIX X

LISTING OF GENERATED COBOL PROGRAM

APPENDIX X

LISTING OF GENRATED COBOL PROGRAM

Pages 2 to 9 of this appendix list the COBOL program statements which would be generated to solve the model problem described in Section 5.9 of the main text of this thesis. Page 10 contains a sample of program output.

A vertical line at the left-hand side of certain listing lines is used to indicate statements which come from 'grown' macros. Intermediate blank lines in the program listing are not significant.

```
*IDENTITY COBL
*COMPILE
*COBOL CARDS (GENPROG)
*OBJECT EDS (ICLA-DEFAULT)
*STANDARD
*CONSOLIDATE EDS XPCK
*SUBGROUPS EDS (SUBGROUPS-RS)
*LOAD
*LIST S P
****
       IDENTIFICATION DIVISION.
       PROGRAM-ID. COBL01.
       DATE-WRITTEN. 09/12/77.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SOURCE-COMPUTER. ICL-1907.
       OBJECT-COMPUTER. ICL-1907 MEMORY SIZE 19000 WORDS.
       SPECIAL-NAMES.
           *DATE IS Z-DATE *TIME IS Z-TIME.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL. SELECT Z-REPORT-FILE ASSIGN TO PRINTER 1.
           SELECT Z-FILE-1 ASSIGN TO TAPES 1.
           SELECT Z-FILE-2 ASSIGN TO TAPES 2.
           SELECT Z-FILE-3 ASSIGN TO CARD-READER 1.
       DATA DIVISION.
       FILE SECTION.
       FD  Z-REPORT-FILE
           LABEL RECORDS OMITTED
           DATA RECORD IS Z-OUTREC.
       01  Z-OUTREC PICTURE X(70).
       FD  Z-FILE-1
           BLOCK CONTAINS 396 CHARACTERS
           RECORD CONTAINS 66 CHARACTERS
           LABEL RECORDS STANDARD VALUE OF ID "DEPARTMENT  "
           DATA RECORD IS Z-INREC1.
       01  Z-INREC1.
           02 Z-IN-REC1-1.
              03 FILLER PICTURE X(4).
              03 DEPT-NO PICTURE 9(2).
              03 FILLER PICTURE X(40).
              03 DEPT-MANAGER PICTURE X(20).
       FD  Z-FILE-2
           BLOCK CONTAINS 490 CHARACTERS
           RECORD CONTAINS 70 CHARACTERS
           LABEL RECORDS STANDARD VALUE OF ID "PERSONNEL   "
           DATA RECORD IS Z-INREC2.
       01  Z-INREC2.
           02 Z-IN-REC2-1.
              03 FILLER PICTURE X(4).
              03 EMPLOYEE-NO PICTURE 9(4).
              03 FILLER PICTURE X(52).
              03 JOIN-YEAR PICTURE 9(2).
              03 JOIN-MONTH PICTURE 9(2).
              03 JOIN-DAY PICTURE 9(2).
              03 FILLER PICTURE X(4).
```

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FD  Z-FILE-3
    BLOCK CONTAINS 80 CHARACTERS
    RECORD CONTAINS 80 CHARACTERS
    LABEL RECORDS OMITTED
    DATA RECORD IS Z-INREC3.
01  Z-INREC3.
    02 Z-IN-REC3-1.
       03 DEPT-NO PICTURE X(2).
       03 EMPLOYEE-NO PICTURE X(4).
       03 EMPLOYEE-NAME PICTURE X(20).
       03 FILLER PICTURE X(54).
WORKING-STORAGE SECTION.
77  Z-EOF-1 PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-EOF-2 PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-EOF-3 PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-EOF-COUNT PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z PICTURE 9 USAGE COMPUTATIONAL.
77  Z1 PICTURE 9 USAGE COMPUTATIONAL.
77  Z-LINE-COUNT PICTURE 99 VALUE 0 USAGE COMPUTATIONAL.
77  Z-PAGE-SWITCH PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-ADV-LINES PICTURE 99 VALUE 0 USAGE COMPUTATIONAL.
77  Z-IGNORE PICTURE 9 VALUE 0 USAGE COMPUTATIONAL.
77  Z-MAX-LINES PICTURE 99 VALUE 45 USAGE COMPUTATIONAL.
01  Z-CONTROL-TOTALS.
    02 Z-LEVEL-1.
       03 MONTHS-SERVICE PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
       03 NO-EMPLOYEES PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
    02 Z-LEVEL-0.
       03 MONTHS-SERVICE PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
       03 NO-EMPLOYEES PICTURE S9(18)
          VALUE 0 USAGE COMPUTATIONAL.
01  Z-LINE-COUNTS.
    02 Z-L-C-1 PICTURE 99 VALUE 6 USAGE COMPUTATIONAL.
    02 Z-L-C-2 PICTURE 99 VALUE 1 USAGE COMPUTATIONAL.
01  FILLER REDEFINES Z-LINE-COUNTS.
    02 Z-L-C PICTURE 99 OCCURS 2 TIMES USAGE COMPUTATIONAL.
01  Z-CONTROL-BREAK.
    02 DEPT-NO PICTURE 9(2).
01  Z-TITLE-1.
    02 FILLER PICTURE X(15) VALUE SPACES.
    02 FILLER PICTURE X(38) VALUE
    " X.Y.Z. MANUFACTURING COMPANY LIMITED ".
01  Z-TITLE-2.
    02 FILLER PICTURE X(24) VALUE SPACES.
    02 FILLER PICTURE X(21) VALUE
    " LONG SERVICE REPORT ".
01  Z-TITLE-3.
    02 FILLER PICTURE X(28) VALUE SPACES.
    02 FILLER PICTURE X(14) VALUE
    " CONFIDENTIAL ".
01  Z-PAGE-1.
    02 FILLER PICTURE X(57) VALUE
    " LONG SERVICE REPORT FOR THE YEAR ENDING 31ST DECEMBER 19".
   02 FILLER PICTURE X(8) VALUE
    "77 PAGE ".
    02 Z-PAGE-COUNT PICTURE ZZZ9.
```

```
01  Z-HEAD1-1.
    02 FILLER PICTURE X(16) VALUE
    " DEPARTMENT NO. ".
    02 DEPT-NO PICTURE Z9.
    02 FILLER PICTURE X(22) VALUE
    "  DEPARTMENT MANAGER  ".
    02 DEPT-MANAGER PICTURE X(20).
01  Z-HEAD1-2.
    02 FILLER PICTURE X(57) VALUE
    " EMPLOYEE NO. EMPLOYEE NAME          DATE OF JOINING LENGT".

    02 FILLER PICTURE X(13) VALUE
    "H OF SERVICE ".
01  Z-HEAD1-3.
    02 FILLER PICTURE X(35) VALUE SPACES.
    02 FILLER PICTURE X(16) VALUE
    " DAY MONTH YEAR ".
    02 FILLER PICTURE X(5) VALUE SPACES.
    02 FILLER PICTURE X(14) VALUE
    " YEARS MONTHS ".
01  Z-DETAIL-1.
    02 FILLER PICTURE X(3) VALUE SPACES.
    02 EMPLOYEE-NO PICTURE ZZZ9.
    02 FILLER PICTURE X(7) VALUE SPACES.
    02 EMPLOYEE-NAME PICTURE X(20).
    02 FILLER PICTURE X(3) VALUE SPACES.
    02 JOIN-DATE PICTURE XXBBBXXBBBXX.
    02 FILLER PICTURE X(11) VALUE SPACES.
    02 L-O-S-YEARS PICTURE Z9.
    02 FILLER PICTURE X(2) VALUE SPACES.
    02 L-O-S-MONTHS PICTURE Z9.
01  Z-SUBTOTAL1-1.
    02 FILLER PICTURE X(16) VALUE
    " DEPARTMENT NO. ".
    02 DEPT-NO PICTURE Z9.
    02 FILLER PICTURE X(19) VALUE
    "  NO. OF EMPLOYEES ".
    02 NO-EMPLOYEES PICTURE ZZZ9.
    02 FILLER PICTURE X(19) VALUE
    "   AVERAGE SERVICE ".
    02 AV-SER-YEARS PICTURE Z9.
    02 FILLER PICTURE X(2) VALUE SPACES.
    02 AV-SER-MONTHS PICTURE Z9.
01  Z-TOTAL-1.
    02 FILLER PICTURE X(16) VALUE
    " COMPANY TOTAL  ".
    02 NO-EMPLOYEES PICTURE ZZZ9.
    02 FILLER PICTURE X(11) VALUE
    " EMPLOYEES ".
01  Z-TOTAL-2.
    02 FILLER PICTURE X(30) VALUE
    " AVERAGE LENGTH OF SERVICE    ".
    02 AV-SER-YEARS PICTURE Z9.
    02 FILLER PICTURE X(7) VALUE
    " YEARS ".
    02 AV-SER-MONTHS PICTURE Z9.
    02 FILLER PICTURE X(8) VALUE
    " MONTHS ".
```

```
01  Z-TUPLE.
    02 ZDATE PICTURE X(8).
    02 ZTIME PICTURE X(8).
    02 Z-PAGE-COUNT PICTURE 9999 VALUE 0 USAGE COMPUTATIONAL.
    02 DEPT-MANAGER PICTURE X(20).
    02 DEPT-NO PICTURE S9(2) USAGE COMPUTATIONAL.
    02 EMPLOYEE-NAME PICTURE X(20).
    02 EMPLOYEE-NO PICTURE S9(4) USAGE COMPUTATIONAL.
    02 JOIN-DAY PICTURE S9(2) USAGE COMPUTATIONAL.
    02 JOIN-MONTH PICTURE S9(2) USAGE COMPUTATIONAL.
    02 JOIN-YEAR PICTURE S9(2) USAGE COMPUTATIONAL.
    02 WORK-ITEM PICTURE S9(18) COMPUTATIONAL VALUE
    0.
    02 L-O-S-YEARS PICTURE S9(2) COMPUTATIONAL VALUE
    0.
    02 L-O-S-MONTHS PICTURE S9(2) COMPUTATIONAL VALUE
    0.
    02 NO-EMPLOYEES PICTURE S9(1) COMPUTATIONAL VALUE
    1.
    02 AV-SER-YEARS PICTURE S9(2) COMPUTATIONAL VALUE
    0.
    02 AV-SER-MONTHS PICTURE S9(2) COMPUTATIONAL VALUE
    0.
    02 MONTHS-SERVICE PICTURE S9(3) COMPUTATIONAL VALUE
    0.
    02 JOIN-DATE.
       03 Z-JOIN-DAY PICTURE X(2).
       03 Z-JOIN-MONTH PICTURE X(2).
       03 Z-JOIN-YEAR PICTURE X(2).
01  Z-TUPLE-N.
    02 DEPT-MANAGER PICTURE X(20).
    02 DEPT-NO PICTURE S9(2) USAGE COMPUTATIONAL.
    02 EMPLOYEE-NAME PICTURE X(20).
    02 EMPLOYEE-NO PICTURE S9(4) USAGE COMPUTATIONAL.
    02 JOIN-DAY PICTURE S9(2) USAGE COMPUTATIONAL.
    02 JOIN-MONTH PICTURE S9(2) USAGE COMPUTATIONAL.
    02 JOIN-YEAR PICTURE S9(2) USAGE COMPUTATIONAL.
PROCEDURE DIVISION.
Z-INITIAL SECTION.
Z-PARA-1. OPEN INPUT
    Z-FILE-1
    Z-FILE-2
    Z-FILE-3
    OUTPUT Z-REPORT-FILE.
    PERFORM Z-END-PAGE-COUNTS VARYING Z FROM 2 BY -1 UNTIL Z
    EQUALS 1.
    PERFORM Z-START-LINE VARYING Z FROM 1 BY 1 UNTIL Z GREATER
    THAN 2.
    ACCEPT ZDATE IN Z-TUPLE FROM Z-DATE.
    ACCEPT ZTIME IN Z-TUPLE FROM Z-TIME.
    PERFORM Z-READ-1.
    PERFORM Z-READ-2.
    PERFORM Z-READ-3.
Z-PARA-2.
    PERFORM Z-FETCH-TUPLE. IF Z-IGNORE EQUALS 1 GO TO Z-PARA-2.
    MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.
    MOVE CORRESPONDING Z-TUPLE TO Z-CONTROL-BREAK.
    PERFORM Z-PARA-TITLE.
    PERFORM Z-PARA-PAGE.
```

```
Z-PROCESSING SECTION.
Z-PARA-3.
    MOVE JOIN-DAY IN Z-TUPLE TO Z-JOIN-DAY IN
    JOIN-DATE IN Z-TUPLE.
    MOVE JOIN-MONTH IN Z-TUPLE TO Z-JOIN-MONTH IN
    JOIN-DATE IN Z-TUPLE.
    MOVE JOIN-YEAR IN Z-TUPLE TO Z-JOIN-YEAR IN
    JOIN-DATE IN Z-TUPLE.
    SUBTRACT JOIN-YEAR IN Z-TUPLE FROM
    77 GIVING
    WORK-ITEM IN Z-TUPLE.
    MULTIPLY WORK-ITEM IN Z-TUPLE BY
    12 GIVING
    MONTHS-SERVICE IN Z-TUPLE.
    SUBTRACT JOIN-MONTH IN Z-TUPLE FROM
    13 GIVING
    WORK-ITEM IN Z-TUPLE.
    ADD WORK-ITEM IN Z-TUPLE,
    MONTHS-SERVICE IN Z-TUPLE GIVING
    MONTHS-SERVICE IN Z-TUPLE.
    DIVIDE MONTHS-SERVICE IN Z-TUPLE BY
    12 GIVING
    L-O-S-YEARS IN Z-TUPLE
    REMAINDER L-O-S-MONTHS IN Z-TUPLE.
    IF
    L-O-S-YEARS IN Z-TUPLE NOT LESS THAN
    10
    GO TO Z-PARA-4. GO TO Z-PARA-5.
Z-PARA-4.
    PERFORM Z-PARA-ADD.
    PERFORM Z-PARA-WRITE.
Z-PARA-5. PERFORM Z-FETCH-TUPLE.
    IF Z-IGNORE EQUALS 1 GO TO Z-PARA-5.
    PERFORM Z-SEQUENCE-BREAK. GO TO Z-PARA-3.
Z-FINAL SECTION.
Z-PARA-FINAL.
    PERFORM Z-TOTAL1.
    IF Z-LINE-COUNT GREATER THAN 43 PERFORM Z-PARA-PAGE.
    DIVIDE MONTHS-SERVICE IN Z-LEVEL-0 BY
    NO-EMPLOYEES IN Z-LEVEL-0 GIVING
    WORK-ITEM IN Z-TUPLE.
    DIVIDE WORK-ITEM IN Z-TUPLE BY
    12 GIVING
    AV-SER-YEARS IN Z-TUPLE
    REMAINDER AV-SER-MONTHS IN Z-TUPLE.
    PERFORM Z-TOTAL0-WRITE.
Z-CLOSE-DOWN. CLOSE
    Z-FILE-1
    Z-FILE-2
    Z-FILE-3
    Z-REPORT-FILE. STOP RUN.
Z-OTHER-PROCEDURES SECTION.
Z-PARA-ADD. ADD CORRESPONDING Z-TUPLE TO Z-LEVEL-1.
Z-PARA-WRITE.
    IF Z-LINE-COUNT GREATER THAN Z-L-C(2) PERFORM Z-PARA-PAGE.
    MOVE CORRESPONDING Z-TUPLE TO Z-DETAIL-1.
    ADD 1 TO Z-ADV-LINES.
    WRITE Z-OUTREC FROM Z-DETAIL-1 AFTER ADVANCING Z-ADV-LINES.
    MOVE 0 TO Z-ADV-LINES.
    ADD 1 TO Z-LINE-COUNT.
    MOVE 0 TO Z-PAGE-SWITCH.
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Z-END-PAGE-COUNTS. COMPUTE Z1 = Z - 1.
    ADD Z-L-C(Z) TO Z-L-C(Z1).
Z-START-LINE. COMPUTE Z-L-C(Z) = Z-MAX-LINES - Z-L-C(Z).
Z-HEAD1.
    IF Z-LINE-COUNT GREATER THAN Z-L-C(1) PERFORM Z-PARA-PAGE
    GO TO Z-HEAD1-EXIT.
    IF Z-PAGE-SWITCH EQUALS 1 GO TO Z-HEAD1-EXIT.
    PERFORM Z-HEAD1-WRITE.
Z-HEAD1-EXIT. EXIT.
Z-TOTAL1.
    IF Z-LINE-COUNT GREATER THAN 42 PERFORM Z-PARA-PAGE.
    DIVIDE MONTHS-SERVICE IN Z-LEVEL-1 BY
    NO-EMPLOYEES IN Z-LEVEL-1 GIVING
    WORK-ITEM IN Z-TUPLE.
    DIVIDE WORK-ITEM IN Z-TUPLE BY
    12 GIVING
    AV-SER-YEARS IN Z-TUPLE
    REMAINDER AV-SER-MONTHS IN Z-TUPLE.
    PERFORM Z-TOTAL1-WRITE.
    MOVE Ø TO Z-PAGE-SWITCH.
    ADD CORRESPONDING Z-LEVEL-1 TO Z-LEVEL-Ø.
    SUBTRACT CORRESPONDING Z-LEVEL-1 FROM Z-LEVEL-1.
Z-PARA-TITLE.
    MOVE SPACES TO Z-OUTREC.
    WRITE Z-OUTREC BEFORE ADVANCING CHANNEL-1.
    WRITE Z-OUTREC FROM Z-TITLE-1 AFTER ADVANCING 12 LINES.
    WRITE Z-OUTREC FROM Z-TITLE-2 AFTER ADVANCING 2 LINES.
    WRITE Z-OUTREC FROM Z-TITLE-3 AFTER ADVANCING 2 LINES.
Z-PARA-PAGE.
    MOVE SPACES TO Z-OUTREC. ADD 1 TO Z-PAGE-COUNT IN Z-TUPLE.
    WRITE Z-OUTREC BEFORE ADVANCING CHANNEL-1.
    MOVE CORRESPONDING Z-TUPLE TO Z-PAGE-1.
    WRITE Z-OUTREC FROM Z-PAGE-1 AFTER ADVANCING 2 LINES.
    MOVE 1 TO Z-ADV-LINES.
    MOVE 4 TO Z-LINE-COUNT.
    MOVE 1 TO Z-PAGE-SWITCH.
    PERFORM Z-HEAD1-WRITE.
Z-HEAD1-WRITE.
    ADD 2 TO Z-ADV-LINES.
    WRITE Z-OUTREC FROM Z-HEAD1-1 AFTER ADVANCING Z-ADV-LINES.
    WRITE Z-OUTREC FROM Z-HEAD1-2 AFTER ADVANCING 2 LINES.
    WRITE Z-OUTREC FROM Z-HEAD1-3 AFTER ADVANCING 1 LINES.
    MOVE 1 TO Z-ADV-LINES.
    ADD 6 TO Z-LINE-COUNT.
Z-TOTAL1-WRITE.
    ADD 2 TO Z-ADV-LINES.
    MOVE CORRESPONDING Z-LEVEL-1 TO Z-SUBTOTAL1-1.
    MOVE DEPT-NO IN Z-TUPLE TO DEPT-NO IN
    Z-SUBTOTAL1-1.
    MOVE AV-SER-YEARS IN Z-TUPLE TO AV-SER-YEARS IN
    Z-SUBTOTAL1-1.
    MOVE AV-SER-MONTHS IN Z-TUPLE TO AV-SER-MONTHS IN
    Z-SUBTOTAL1-1.
    WRITE Z-OUTREC FROM Z-SUBTOTAL1-1 AFTER Z-ADV-LINES.
    MOVE 1 TO Z-ADV-LINES.
    ADD 3 TO Z-LINE-COUNT.
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Z-TOTAL0-WRITE.
    ADD 2 TO Z-ADV-LINES.
    MOVE CORRESPONDING Z-LEVEL-0 TO Z-TOTAL-1.
    WRITE Z-OUTREC FROM Z-TOTAL-1 AFTER ADVANCING Z-ADV-LINES.
    MOVE CORRESPONDING Z-TUPLE TO Z-TOTAL-2.
    WRITE Z-OUTREC FROM Z-TOTAL-2 AFTER ADVANCING 1 LINES.
Z-READ-1 SECTION.
Z-READ-1-1. READ Z-FILE-1 AT END GO TO Z-READ-1-2.
    GO TO Z-READ-1-EXIT.
Z-READ-1-2. MOVE 1 TO Z-EOF-1.
Z-READ-1-EXIT. EXIT.
Z-READ-2 SECTION.
Z-READ-2-1. READ Z-FILE-2 AT END GO TO Z-READ-2-2.
    GO TO Z-READ-2-EXIT.
Z-READ-2-2. MOVE 1 TO Z-EOF-2.
Z-READ-2-EXIT. EXIT.
Z-READ-3 SECTION.
Z-READ-3-1. READ Z-FILE-3 AT END GO TO Z-READ-3-2.
    GO TO Z-READ-3-EXIT.
Z-READ-3-2. MOVE 1 Z-EOF-3.
    ADD 1 TO Z-EOF-COUNT.
Z-READ-3-EXIT. EXIT.
Z-SEQUENCE-BREAK SECTION.
Z-BREAK-1.
    IF DEPT-NO IN Z-TUPLE-N EQUALS DEPT-NO IN
    Z-CONTROL-BREAK GO TO Z-BREAK-1-EXIT.
    PERFORM Z-TOTAL1.
    MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.
    MOVE CORRESPONDING Z-TUPLE TO Z-CONTROL-BREAK.
    PERFORM Z-HEAD1 THRU Z-HEAD1-EXIT.
    GO TO Z-BREAK-EXIT.
Z-BREAK-1-EXIT. EXIT.
Z-BREAK-MOVE. MOVE CORRESPONDING Z-TUPLE-N TO Z-TUPLE.
Z-BREAK-EXIT. EXIT.
Z-FETCH-TUPLE SECTION.
Z-END-OF-DATA-TEST. IF Z-EOF-COUNT EQUALS 1 GO TO Z-FINAL.
    MOVE 0 TO Z-IGNORE.
Z-SET-TUPLE-KEY.
    MOVE DEPT-NO IN Z-INREC3 TO DEPT-NO
    IN Z-TUPLE-N.
    MOVE EMPLOYEE-NO IN Z-INREC3 TO EMPLOYEE-NO
    IN Z-TUPLE-N.
Z-SET-TUPLE-DATA-1.
    IF Z-EOF-1 EQUALS 1 GO TO Z-OPTION-1.
Z-MATCH-1.
    IF DEPT-NO IN Z-INREC1 GREATER THAN
    DEPT-NO IN Z-TUPLE-N GO TO Z-OPTION-1.
    IF DEPT-NO IN Z-INREC1 LESS THAN
    DEPT-NO IN Z-TUPLE-N GO TO Z-FETCH-1.
    MOVE DEPT-MANAGER IN Z-INREC1 TO DEPT-MANAGER
    IN Z-TUPLE-N.
    GO TO Z-MOVE-1-EXIT.
Z-FETCH-1. PERFORM Z-READ-1.
    IF Z-EOF-1 EQUALS 0 GO TO Z-MATCH-1.
    CLOSE Z-FILE-1 RETAIN OPEN INPUT Z-FILE-1 MOVE 0 TO Z-EOF-1.

    PERFORM Z-READ-1.
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Z-OPTION-1.
    MOVE 1 TO Z-IGNORE.
Z-MOVE-1-EXIT. EXIT.
Z-SET-TUPLE-DATA-2.
    IF Z-EOF-2 EQUALS 1 GO TO Z-OPTION-2.
Z-MATCH-2.
    IF EMPLOYEE-NO IN Z-INREC2 GREATER THAN
    EMPLOYEE-NO IN Z-TUPLE-N GO TO Z-OPTION-2.
    IF EMPLOYEE-NO IN Z-INREC2 LESS THAN
    EMPLOYEE-NO IN Z-TUPLE-N GO TO Z-FETCH-2.
    MOVE JOIN-YEAR IN Z-INREC2 TO JOIN-YEAR
    IN Z-TUPLE-N.
    MOVE JOIN-MONTH IN Z-INREC2 TO JOIN-MONTH
    IN Z-TUPLE-N.
    MOVE JOIN-DAY IN Z-INREC2 TO JOIN-DAY
    IN Z-TUPLE-N.

    GO TO Z-MOVE-2-EXIT.
Z-FETCH-2. PERFORM Z-READ-2.
    IF Z-EOF-2 EQUALS 0 GO TO Z-MATCH-2.
    CLOSE Z-FILE-2 RETAIN OPEN INPUT Z-FILE-2 MOVE 0 TO Z-EOF-2.

    PERFORM Z-READ-2.
Z-OPTION-2.
    MOVE 1 TO Z-IGNORE.
Z-MOVE-2-EXIT. EXIT.
Z-SET-TUPLE-DATA-3.
    MOVE EMPLOYEE-NAME IN Z-INREC3 TO EMPLOYEE-NAME
    IN Z-TUPLE-N.

    PERFORM Z-READ-3.
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LONG SERVICE REPORT FOR THE YEAR ENDING 31ST DECEMBER 1977 PAGE 3

DEPARTMENT NO. 10 DEPARTMENT MANAGER F.G. PAYTON-MCDOWELL

EMPLOYEE NO.	EMPLOYEE NAME	DATE OF JOINING DAY	MONTH	YEAR	LENGTH OF SERVICE YEARS	MONTHS
1340	F.G. PAYTON-MCDOWELL	16	04	62	15	9
500	J. METCALFE	21	01	66	12	0
550	D.M. MIDLANE	13	12	66	11	1

DEPARTMENT NO. 10 NO. OF EMPLOYEES 3 AVERAGE SERVICE 12 11

DEPARTMENT NO. 12 DEPARTMENT MANAGER C.W. RUSSELL

EMPLOYEE NO.	EMPLOYEE NAME	DATE OF JOINING DAY	MONTH	YEAR	LENGTH OF SERVICE YEARS	MONTHS
620	C.W. RUSSELL	18	06	62	15	7

DEPARTMENT NO. 12 NO. OF EMPLOYEES 1 AVERAGE SERVICE 15 7

DEPARTMENT NO. 14 DEPARTMENT MANAGER B.J.S. MOORE

EMPLOYEE NO.	EMPLOYEE NAME	DATE OF JOINING DAY	MONTH	YEAR	LENGTH OF SERVICE YEARS	MONTHS
910	B.J.S. MOORE	20	04	61	16	9

DEPARTMENT NO. 14 NO. OF EMPLOYEES 1 AVERAGE SERVICE 16 9

COMPANY TOTAL 15 EMPLOYEES
AVERAGE LENGTH OF SERVICE 14 YEARS 6 MONTHS

22. DIAL5 AND STAGE5 SUBFILES

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GWAC132-DATA
59UNIVST
INPUT
DIAL5
STAGE 5 - EXTENSION OF DATABASE
ALTHOUGH YOUR DATABASE MAY ONLY BE EXTENDED ON A PERMANENT BASIS IN
CONSULTATION WITH THE DATABASE ADMINISTRATOR, YOU MAY CREATE NEW DATA
ITEMS WHICH ARE AVAILABLE ONLY DURING THIS SYSTEM SESSION.
THE PROCESSING OF THESE TEMPORARY ITEMS WILL BE ENTIRELY UNDER YOUR
CONTROL AND LATER YOU WILL BE GIVEN AN OPPORTUNITY TO SPECIFY YOUR
PROCESSING REQUIREMENTS.
IT IS AT THIS STAGE YOU SHOULD CREATE ANY ITEMS REQUIRED FOR HOLDING
INTERMEDIATE RESULTS OF CALCULATIONS OR FOR REMAINDERS ARISING FROM
ARITHMETIC DIVISIONS.
YOUR DATABASE MAY ALSO BE TEMPORARILY EXTENDED BY THE INCLUSION OF A
COMPOUND DOMAIN FORMED BY CONCATENATING THE ITEMS FROM TWO OR MORE
OTHER DOMAINS WITHIN THE DATABASE.
E.G. THE TEMPORARY DOMAIN ADDRESS MAY BE COMPOUNDED FROM THE EXISTING
DOMAINS STREET, TOWN AND POSTCODE. COMPOUND DOMAINS ARE ALWAYS OF
ALPHANUMERIC TYPE.
********
INPUT
STAGE5
%DEF    STAGE500
%       NOTE: EXTENSION OF DATABASE - CHECK POINT 5
%       NOTE: SET CHECK POINT NO.
%       #GCKPT=5
%       NOTE: PRINT INTRODUCTORY DIALOGUE FOR STAGE 5
%       SELECT DIAL5
%       #LLINE=1
%5000   FREAD #LLINE,#S01
%       DEPOSITO #S01$
%       WRITE
%       #LLINE=#LLINE+1
%       IF #LLINE.LE.16,GOTO 5000
%       NOTE: SELECT DOMAIN LIST, READ AND EXTRACT COUNT
%       SELECT DOMAINLIST
%       FREAD 1,#GDMCT
%       CALLCONV(#GDMCT,#GDMCT)
%       NOTE: COMPUTE MAX VALUE OF RECORD POINTER
%       #LMAX=#GDMCT+1
%       NOTE: INITIALISE RECORD POINTERS
%       #LREC=2
%       #LPTR=1
%       NOTE: COPY DOMAINLIST TO DOMAININDEX SUBFILE
%2      FREAD #LREC,#S01
%       SELECT DOMAININDEX
%       INSERT #LPTR,#S01
%       NOTE: UPDATE POINTERS AND READ NEXT RECORD FROM DOMAIN LIST
%       #LREC=#LREC+1
%       #LPTR=#LPTR+1
%       IF #LREC .GT. #LMAX,GOTO 30
%       SELECT DOMAINLIST
%       GOTO 2
%       NOTE: GENERATE FIRST STATEMENTS FOR TEMPITEM MACRO
%30     CONTINUE
%       @10DEF  TEMPITEM
%       @10     LABELOFF
%       NOTE: OFFER USER OPTION TO CREATE TEMPORARY ITEMS
%3      DEPOSITO DO%YOU%WISH%TO%CREATE%ANY%TEMPORARY%DATA%ITEMS?$
%       WRITE
%       CALL 2200
%       NOTE: READ AND VALIDATE USERS REPLY
%7      CALL 9000
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      %       SQUASH
      %       IF #GSTC.GT.1,GOTO 6
      %       CALLFSTR(#LV1,1,1)
      %       IF #LV1.IN.'N',GOTO 4
      %       IF #LV1.EQ.'Y',GOTO 5
      %       NOTE: INVALID RESPONSE
      %6      OBEY 2100,7
      %       NOTE: OFFER USER OPTION TO CREATE ALPHANUMERIC ITEMS
      %5      DEPOSITO DO%YOU%WISH%TO%CREATE%ANY%TEMPORARY%ITEMS%WHICH%CONTAINS$
      %       WRITE
      %       DEPOSITO ALPHANUMERIC%DATA?$
      %31     WRITE
      %       CALL 2200
      %       NOTE: READ AND VALIDATE USERS REPLY
      %9      CALL 9000
      %       SQUASH
      %       IF #GSTC.GT.1;GOTO 8
      %       CALLFSTR(#LV1,1,1)
      %       IF #LV1.EQ.'Y',GOTO 10
      %       IF #LV1.IN.'N',GOTO 26
      %       NOTE: INVALID RESPONSE
      %       OBEY 2100,9
      %       NOTE: REQUEST,READ AND VALIDATE ITEM NAME.
      %10     DEPOSITO PLEASE%TYPE%THE%NAME%OF%THE%ALPHANUMERIC%ITEM$
      %       WRITE
      %12     CALL 9000
      %       WRITE #S09
      %       #LLENG=15
      %       CALL 200
      %       IF #LNERR.EQ.0,GOTO 11
      %       NOTE: INVALID NAME
      %       DEPOSITO #S09%IS%AN%INVALID%NAME%FOR%REASON%LISTED%ABOVE$
      %       WRITE
      %       GOTO 12
      %       NOTE: BINARY SEARCH DOMAININDEX FOR DURLICATE NAME
      %11     CALL 8000
      %       IF #LIND.EQ.0,GOTO 13
      %       DEPOSITO DOMAIN%#S09%ALREADY%EXISTS!%PLEASE%THINK%OF%A%NEW%NAME.$
      %       WRITE
      %       GOTO 12
      %       NOTE: REQUEST SIZE OF ITEM
      %13     DEPOSITO HOW%MANY%CHARACTERS%DOES%ITEM%#S09%CONTAIN?
      %       WRITE
      %       DEPOSITO THE%DEFAULT%REPLY%IS%30.
      %       WRITE
      %       NOTE: READ AND VALIDATE SIZE
      %17     CALL 9000
      %       SQUASH
      %       IF #GSTC.LT.1;GOTO 18
      %       IF #GSTC.GT.2;GOTO 14
      %       #GINP=1
      %       #GOUP=#GSTC
      %15     CALLFSTR(#LV1,0,1)
      %       TESTDIGT(#LV1)
      %       IF #GTST.NE.0;GOTO 14
      %       #GINP=#GINP+1
      %       IF #GINP.LE.#GSTC;GOTO 15
      %       CALLFSTR(#LSIZE,1,0)
      %       #GOUP=1
      %       CALLCONV(#LSIZE,#LSIZE)
      %       IF #LSIZE.LT.1,GOTO 14
      %       IF #LSIZE.GT.58,GOTO 14
      %       GOTO 16
      %       NOTE: INVALID SIZE
      %14     DEPOSITO SIZE%INVALID.%IT%MUST%LIE%IN%THE%RANGE%1%TO%58$
      %       WRITE
      %       GOTO 17
      %18     #LSIZE=30
```

```
(12)  133 %       NOTE: REQUEST INITIAL VALUE
      134 %16     DEPOSIT0 DO%YOU%WISH%TO%ENTER%AN%INITIAL%VALUE%IN%#S09?$
      135 %       WRITE
      136 %       CALL 2200
      137 %       DEPOSIT0 BY%DEFAULT%THE%ITEM%WILL%INITIALLY%CONTAIN%BLANKS.$
      138 %       WRITE
      139 %       NOTE: READ AND VALIDATE USERS RESPONSE
      140 %20     CALL 9000
      141 %       SQUASH
      142 %       IF #GSTC.GT.1,GOTO 19
      143 %       CALLFSTR(#LV1,1,1)
      144 %       IF #LV1.IN.' N',GOTO 21
      145 %       IF #LV1.EQ.'Y',GOTO 22
      146 %       NOTE: INVALID RESPONSE
      147 %19     OBEY 2100,20
      148 %       NOTE: REQUEST INITIAL VALUE
      149 %22     DEPOSIT0 PLEASE%ENTER%THE%INITIAL%VALUE%FOR%#S09.%THE%CHARACTERS%$
      150 %       WRITE
      151 %       DEPOSIT0 YOU%TYPE%WILL%BE%PLACED%LEFT%JUSTIFIED%IN%THE%ITEM%AND$
      152 %       WRITE
      153 %       DEPOSIT0 PADDED%OUT%WITH%BLANKS.%EXCESS%CHARACTERS%WILL%BE%IGNORES
      154 %       CALLCOPY (57,D.)
      155 %       WRITE
      156 %       CALL 9000
      157 %       #GOUP=#LSIZE
      158 %       VSTR1  ,1,0
      159 %       GOTO 23
      160 %       NOTE: INITIAL VALUE BLANK
      161 %21     RESET #S01
      162 %       DEPOSIT1 %$
(13)  163 %       NOTE: ENTER DOMAIN IN DOMAIN INDEX AND UPDATE DOMAIN COUNT
      164 %23     RESET #S02
      165 %       DEPOSIT2 #S09,E,#LSIZE,A,,0,,N,S
      166 %       INSERT #LLOU,#S02
      167 %       #GDUCT=#GDUCT+1
(14)  168 %       NOTE: GENERATE COBOL DATA DESCRIPTION
      169 %       LABELOFF
      170                 02 #S09 PICTURE X(#LSIZE) VALUE
      171                 "#S01".
      172 %       LABELON
(15)  173 %       NOTE: ASK IF ANY MORE ALPHANUMERIC ITEMS ARE TO BE CREATED
      174 %       DEPOSIT0 HAVE%YOU%ANY%MORE%ALPHANUMERIC%ITEMS%TO%CREATE?$
      175 %       GOTO 31
      176 %       NOTE: VALIDATE NAME STARTING IN 1ST POSITION OF INPUT BUFFER
      177 %       NOTE: #LNERR = ERROR INDICATOR - INITIALLY CLEARED TO ZERO
      178 %200    #LNERR=0
      179 %       NOTE: TEMPORARILY SAVE CONTENTS OF INPUT BUFFER
      180 %       WRITE #S01
      181 %       SQUASH
      182 %       NOTE: CHECK NO. OF CHARACTERS KEYED
      183 %       IF #GSTC.GT.#LLENG,GOTO 202
      184 %       NOTE: CHECK FOR IMBEDDED BLANKS
      185 %209    WRITE #S02
      186 %       IF #S01.NE.#S02,GOTO 203
      187 %       NOTE: CHECK FIRST CHARACTER FOR HYPHEN OR Z
      188 %210    CALLFSTR(#LV1,1,1)
      189 %       IF #LV1.IN.'-Z',GOTO 204
      190 %       NOTE: CHECK LAST CHARACTER FOR HYPHEN
      191 %211    #GINP=#GSTC
      192 %       CALLFSTR(#LV1,0,1)
      193 %       IF #LV1.EQ.'-',GOTO 205
      194 %       NOTE: SET UP LOOP TO CHECK FOR ALPHABETIC, NUMERIC AND HYPHEN ONLY
      195 %212    #GINP=1
      196 %       NOTE: ZEROISE COUNT OF ALPHA CHARACTERS
      197 %       #LALPH=0
      198 %       NOTE: EXTRACT NEXT CHARACTER
      199 %213    CALLFSTR(#LV1,0,1)
      200 %       NOTE: TEST NUMERIC
```

```
201 %       TESTDIGT(#LV1)
202 %       IF #GTST.EQ.0,GOTO 206
203 %       NOTE: TEST ALPHABETIC
204 %       TESTLETR(#LV1)
205 %       IF #GTST.EQ.0,GOTO 207
206 %       NOTE: TEST HYPHEN
207 %       IF #LV1.EQ.'-',GOTO 206
208 %       NOTE: INVALID CHARACTER FOUND
209 %       DEPOSITO #LV1%INVALID%CHARACTER.%ONLY%A%TO%Z,%0%TO%9%AND%-%ALLOWED$
210 %       CALLCOPY(54,D)
211 %       WRITE
212 %       NOTE: SET ERROR INDICATOR ON
213 %       #LNERR=1
214 %       NOTE: UPDATE POINTER AND TEST FOR END OF LOOP
215 %206   #GINP=#GINP+1
216 %       IF #GINP.GT.#GSTC,GOTO 214
217 %       GOTO 213
218 %       NOTE: TEST FOR AT LEAST ONE ALPHA CHARACTER
219 %214   IF #LALPH.GT.0,GOTO 208
220 %       NOTE: NO ALPHA CHARACTER PRESENT
221 %       DEPOSITO AT%LEAST%ONE%ALPHABETIC%CHARACTER%MUST%BE%INCLUDED$
222 %       WRITE
223 %       #LNERR=1
224 %208   EXIT
225 %       NOTE: NAME TOO LONG
226 %202   DEPOSITO MORE%THAN%#LLENG%CHARACTERS%IN%NAME$
227 %       WRITE
228 %       #LNERR=1
229 %       GOTO 209
230 %       NOTE: BLANK%NOT%ALLOWED$
231 %       DEPOSITO BLANKS%NOT%ALLOWED$
232 %       WRITE
233 %       #LNERR=1
234 %       GOTO 210
235 %       NOTE: FIRST CHARACTER HYPHEN OR Z
236 %204   DEPOSITO Z%OR%HYPHEN%NOT%ALLOWED%AS%FIRST%CHARACTERS
237 %       WRITE
238 %       #LNERR=1
239 %       GOTO 211
240 %       NOTE: LAST CHARACTER HYPHEN
241 %205   DEPOSITO HYPHEN%NOT%ALLOWED%AS%LAST%CHARACTERS
242 %       WRITE
243 %       #LNERR=1
244 %       GOTO 212
245 %       NOTE: ADD 1 TO ALPHABETIC COUNT
246 %207   #LALPH=#LALPH+1
247 %       GOTO 206
248 %       NOTE: ROUTINE TO SEARCH DOMAININDEX FOR THE DOMAIN NAME CONTAINED
249 %       NOTE: IN #S09
250 %       NOTE:   DOMAIN COUNT=#GDMCT
251 %       NOTE: #LIND= INDICATOR 0=FOUND 1=NOT FOUND
252 %8000  #LIND=0
253 %       SELECT DOMAININDEX
254 %       #LLOW=1
255 %       #LHIGH=#GDMCT
256 %8005  IF #LLOW.GT.#LHIGH,GOTO 8001
257 %       #LCUR=#LLOW+#LHIGH
258 %       #LCUR=#LCUR/2
259 %       FREAD #LCUR #S01
260 %       NOTE: EXTRACT DOMAIN NAME
261 %       VSTR2 #S01,1,,
262 %       IF #S02:GT:#S09,GOTO 8002
263 %       IF #S02:LT:#S09,GOTO 8003
264 %8004  EXIT
265 %8001  #LIND=1
266 %       GOTO 8004
267 %8002  #LHIGH=#LCUR-1
268 %       GOTO 8005
```

```
269  %8003 #LLOW=#LCUR+1
270  %     GOTO 8005
271  %     NOTE: CHAIN TO NEXT MACRO
272  %4    CONTINUE
273        [CHAINO,STAGE5-2]
274        [STAGE5-201]
275  %     GOTO 9999
276  %     NOTE: CHAIN TO NEXT MACRO
277  %26   CONTINUE
278        [CHAINO,STAGE5-1]
279        [STAGE5-101]
280  %     GOTO 9999
281  %     NOTE: PRINT INVALID RESPONSE
282  %2100 DEPOSITO INVALID%RESPONSE.$
283  %     WRITE
284  %     RETURN
285  %     NOTE: PRINT PLEASE TYPE MESSAGE
286  %2400 DEPOSITO PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO,%THE%DEFAULT%REPLY%IS%S
287  %     CALLCOPY(57,NO.)
288  %     WRITE
289  %     EXIT
290  %     NOTE: ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
291  %9000 DEPOSITO :$
292  %     WRITE
293  %     READ
294  %     CALLSTR(#LV1,1,5)
295  %     IF #LV1.EQ.'%HELP',GOTO 9001
296  %     EXIT
297  %9001 CONTINUE
298        [CHAINO,HELP]
299        [HELP01]
300  %9999 CONTINUE
301  %END
302  ********
303  INPUT
304  STAGE5-1
305  %DEF  STAGE5-100
306  %26   NOTE: OFFER USER OPTION TO CREATE NUMERIC ITEMS
307  %     DEPOSITO DO%YOU%WISH%TO%CREATE%ANY%TEMPORAY%ITEMS%WHICH%CONTAIN%NS
308  %     CALLCOPY(57,UNERIC%DATA?)
309  %10   WRITE
310  %     CALL 2200
311  %     NOTE: READ AND VALIDATE USERS REPLY
312  %27   CALL 9000
313  %     SQUASH
314  %     IF #GSTC.GT.1,GOTO 28
315  %     CALLSTR(#LV1,1,1)
316  %     IF #LV1.EQ.'Y',GOTO 29
317  %     IF #LV1.IN.' N',GOTO 4
318  %     NOTE: INVALID RESPONSE
319  %28   OBEY 2100,27
320  %     NOTE: REQUEST READ AND VALIDATE ITEM NAME
321  %29   DEPOSITO PLEASE%TYPE%THE%NAME%OF%THE%NUMERIC%ITEM.$
322  %     WRITE
323  %30   CALL 9000
324  %     WRITE #S09
325  %     #GLENG=15
326  %     CALL 200
327  %     IF #LNERR.EQ.0,GOTO 31
328  %     NOTE: INVALID NAME
329  %     DEPOSITO #S09%IS%AN%INVALID%NAME%FOR%REASON%LISTED%ABOVE$
330  %     WRITE
331  %     GOTO 30
332  %     NOTE: BINARY SEARCH DOMAININDEX FOR DUPLICATE NAME
333  %31   CALL 8000
334  %     IF #LIND.EQ.0,GOTO 32
335  %     NOTE: PRINT DUPLICATE NAME MESSAGE
336  %     DEPOSITO DOMAIN%#S00%ALREADY%EXISTI%PLEASE%THINK%OF%A%NEW%NAME.$
```

① ②

23. STAGE5-1 SUBFILE

```
337 %       WRITE
338 %       GOTO 30
339 %       NOTE: REQUEST SIZE OF ITEM
340 %       DEPOSITO OF%HOW%MANY%DIGITS%DOES%#S09%CONSIST?$
341 %       WRITE
342 %       DEPOSITO THE%DEFAULT%REPLY%IS%18.$
343 %       WRITE
344 %       NOTE: READ AND VALIDATE SIZE
345 %       CALL 9000
346 %       SQUASH
347 %       IF #GSTC.LT.1,GOTO 34
348 %       IF #GSTC.GT.2,GOTO 35
349 %       #GINP=1
350 %       #GOUP=#GSTC
351 %36     CALLFSTR(#LV1,C,)
352 %       TESTDIGT(#LV1)
353 %       IF #GTST.NE.0,GOTO 35
354 %       #GINP=#GINP+1
355 %       IF#GINP.LE.#GSTC,GOTO 36
356 %       CALLFSTR(#LSIZE,1,0)
357 %       #GOUP=1
358 %       CALLCONV(#LSIZE,#LSIZE)
359 %       IF #LSIZE.LT.1,GOTO 35
360 %       IF #LSIZE.GT.18,GOTO 35
361 %       GOTO 37
362 %       NOTE: INVALID SIZE
363 %35     DEPOSITO SIZE%INVALID.%IT%MUST%LIE%IN%THE%RANGE%1%TO%18$
364 %       WRITE
365 %       GOTO 33
366 %34     #LSIZE=18
367 %       NOTE: REQUEST DECIMAL POINT LOCATION
368 %       DEPOSITO DO%YOU%WISH%TO%SPECIFY%A%DECIMAL%POINT%LOCATION%OTHERS
369 %       WRITE
370 %       DEPOSITO THAN%AFTER%THE%RIGHTMOST%DIGIT.S
371 %       WRITE
372 %       CALL 2200
373 %       NOTE: READ AND VALIDATE USERS REPLY
374 %38     CALL 9000
375 %       SQUASH
376 %       CALLFSTR(#LV1,1,1)
377 %       IF #LV1.IN.' N',GOTO 40
378 %       IF #LV1.EQ.'Y',GOTO 41
379 %       NOTE: INVALID RESPONSE
380 %       OBEY 2100,38
381 %       NOTE: SET DEFAULT POINT LOCATION VALUES
382 %40     #LDIR='L'
383 %       #LSHFT=0
384 %       GOTO 46
385 %       NOTE: REQUEST DECIMAL POINT LOCATION
386 %41     DEPOSITO IS%THE%DECIMAL%POINT%LOCATED%TO%THE%RIGHT%OR%LEFT%OF%THES
387 %       CALLCOPY(57,%LAST%DIGIT?)
388 %       WRITE
389 %       DEPOSITO PLEASE%TYPE%L%FOR%LEFT%OR%R%FOR%RIGHT.%THE%DEFAULT%REPLYS
390 %       CALLCOPY(57,%IS%RIGHT)
391 %       WRITE
392 %       NOTE: READ AND VALIDATE USERS REPLY
393 %45     CALL 9000
394 %       SQUASH
395 %       IF #GSTC.GT.1,GOTO 42
396 %       CALLFSTR(#LDIR,1,1)
397 %       IF #LDIR.IN.'R ',GOTO 43
398 %       IF #LDIR.EQ.'L',GOTO 44
399 %       NOTE: INVALID RESPONSE
400 %42     OBEY 2100,45
401 %43     #LDIR='R'
402 %       #LWORD='RIGHT'
403 %       GOTO 45
404 %44     #LWORD='LEFT'
```

```
541 %       WRITE
542 %       DEPOSITO LENGTH%OF%A%NUMERIC%LITERAL%IS%60%CHARACTERS.$
543 %       WRITE
544 %       CALL 9000
545 %       GOTO 8100
546 %8103   IF #GSTC EQ #GINP,GOTO 8101
547 %8104   #GINP=#GINP+1
548 %       IF #GINP.LE.#GSTC,GOTO 8102
549 %       GOTO 8106
550 %8105   IF #GINP.EQ.#GSTC,GOTO 8101
551 %8107   #GINP=#GINP+1
552 %       IF #GINP.LE.#GSTC,GOTO 8108
553 %8106   EXIT
554 %8108   CALLFSTR(#LV1,C,1)
555 %       TESTDIGT(#LV1)
556 %       IF #GTST.EQ.1,GOTO 8107
557 %       GOTO 8101
558 %       NOTE: ROUTINE TO SEARCH DOMAININDEX FOR THE DOMAIN NAME CONTAINED
559 %       NOTE: IN #S09
560 %       NOTE: DOMAIN COUNT =#GDUCT
561 %       NOTE: #LIND = INDICATOR 0=FOUND 1=NOT FOUND
562 %8000   #LIND=0
563 %       SELECT DOMAININDEX
564 %       #LLOW=1
565 %       #LHIGH=#GDUCT
566 %8005   IF #LLOW.GT.#LHIGH,GOTO 8001
567 %       #LCUR=#LLOW+#LHIGH
568 %       #LCUR=#LCUR/2
569 %       FREAD #LCUR,#S01
570 %       NOTE: EXTRACT DOMAIN NAME
571 %       VSTR2 #S01,1,,
572 %       IF #S02.GT.#S09,GOTO 8002
573 %       IF #S02.LT.#S09,GOTO 8003
574 %8004   EXIT
575 %8001   #LIND=1
576 %       GOTO 8004
577 %8002   #LHIGH=#LCUR-1
578 %       GOTO 8005
579 %8003   #LLOW=#LCUR+1
580 %       GOTO 8005
581 %       NOTE: VALIDATE NAME STARTING IN 1ST POSITION OF INPUT BUFFER
582 %       NOTE: #LNERR = ERROR INDICATOR - INITIALLY CLEARED TO ZERO
583 %200    #LNERR=0
584 %       NOTE: TEMPORARILY SAVE CONTENTS OF INPUT BUFFER
585 %       WRITE #S01
586 %       SQUASH
587 %       NOTE: CHECK NO. OF CHARACTERS KEYED
588 %       IF #GSTC.GT.#LLENG,GOTO 202
589 %       NOTE: CHECK FOR IMBEDDED BLANKS
590 %209    WRITE #S02
591 %       IF #S02.NE.#S01,GOTO 203
592 %       NOTE: CHECK FIRST CHARACTER FOR HYPHEN OR Z
593 %210    CALLFSTR(#LV1,1,1)
594 %       IF #LV1.IN.'-Z',GOTO 204
595 %       NOTE: CHECK LAST CHARACTER FOR HYPHEN
596 %211    #GINP=#GSTC
597 %       CALLFSTR(#LV1,C,1)
598 %       IF #LV1.EQ.'-',GOTO 205
599 %       NOTE: SET UP LOOP TO CHECK FOR ALPHABETIC, NUMERIC AND HYPHEN ONLY
600 %212    #GINP=1
601 %       NOTE: ZEROISE COUNT OF ALPHA CHARACTERS
602 %       #LALPH=0
603 %       NOTE: EXTRACT NEXT CHARACTER
604 %213    CALLFSTR(#LV1,C,1)
605 %       NOTE: TEST NUMERIC
606 %       TESTDIGT(#LV1)
607 %       IF #GTST.EQ.0,GOTO 206
608 %       NOTE: TEST ALPHABETIC
```

```
609 %       TESTLETR(#LV1)
610 %       IF #GTST.EQ.0,GOTO 207
611 %       NOTE: TEST HYPHEN
612 %       IF #LV1.EQ.'-',GOTO 206
613 %       NOTE: INVALID CHARACTER FOUND
614 %       DEPOSITO #LV1%INVALID%CHARACTER.%ONLY%A%TO%Z,%0%TO%9%AND%-%ALLOWES
615 %       CALLCOPY(54,D)
616 %       WRITE
617 %       NOTE: SET ERROR INDICATOR ON
618 %       #LNERR=1
619 %       NOTE: UPDATE POINTER AND TEST FOR END OF LOOP
620 %206   #GINP=#GINP+1
621 %       IF #GINP.GT.#GSTC,GOTO 214
622 %       GOTO 213
623 %       NOTE: TEST FOR AT LEAST ONE ALPHA CHARACTER
624 %214   IF #LALPH.GT.0,GOTO 208
625 %       NOTE: NO ALPHA CHARACTER PRESENT
626 %       DEPOSITO AT%LEAST%ONE%ALPHABETIC%CHARACTER%MUST%BE%INCLUDEDS
627 %       WRITE
628 %       #LNERR=1
629 %208   EXIT
630 %       NOTE: NAME TOO LONG
631 %202   DEPOSITO MORE%THAN%#LLENG%CHARACTERS%IN%NAMES
632 %       WRITE
633 %       #LNERR=1
634 %       GOTO 209
635 %       NOTE: BLANKS NOT ALLOWED
636 %       DEPOSITO BLANKS%NOT%ALLOWEDS
637 %       WRITE
638 %       #LNERR=1
639 %       GOTO 210
640 %       NOTE: FIRST CHARACTER HYPHEN OR Z
641 %204   DEPOSITO Z%OR%HYPHEN%NOT%ALLOWED%AS%FIRST%CHARACTERS
642 %       WRITE
643 %       #LNERR=1
644 %       GOTO 211
645 %       NOTE: LAST CHARACTER HYPHEN
646 %205   DEPOSITO HYPHEN%NOT%ALLOWED%AS%LAST%CHARACTERS
647 %       WRITE
648 %       #LNERR=1
649 %       GOTO 212
650 %       NOTE: ADD 1 TO ALPHABETIC COUNT
651 %207   #LALPH=#LALPH+1
652 %       GOTO 206
653         NOTE: CHAIN TO NEXT SECTION OF STAGE
654 %4      CONTINUE
655         [CHAINO,STAGE5-2]]
656         [STAGE5-2]
657 %       GOTO 9999
658 %       NOTE: PRINT INVALID RESPONSE MESSAGE
659 %2100  DEPOSITO INVALID%RESPONSE.$
660 %       WRITE
661 %       RETURN
662 %       NOTE: PRINT PLEASE TYPE MESSAGE
663 %2200  DEPOSITO PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO,%THE%DEFAULT%REPLY%IS%$
664 %       CALLCOPY(57,NO.)
665 %       WRITE
666 %       EXIT
667 %       NOTE: ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
668 %9000  DEPOSITO :$
669 %       WRITE
670 %       READ
671 %       CALLVSTR(#LV1,1,5)
672 %       IF #LV1.EQ.'%HELP',GOTO 9001
673 %       EXIT
674 %9001  CONTINUE
675         [CHAINO,HELP]
676 ------  [HELP@16]
```

```
745 %       WRITE
746 %       DEPOSIT0 WILL%BE%CONCATENATED%IN%ORDER%FROM%LEFT%TO%RIGHT.$
747 %       WRITE
748 %76     DEPOSIT0 PLEASE%TYPE%THE%NAME%OF%THE%#LWORD%DOMAIN%TO%BE%CONCATENS
749 %       CALLCOPY(57,ATED)
750 %       WRITE
751 %       NOTE: READ AND VALIDATE DOMAIN NAME
752 %77     CALL 9000
753 %       WRITE #S03
754 %       CALL 8000
755 %       IF #LIND.EQ.1,GOTO 78
756 %       NOTE: DOMAIN NOT IN DATA BASE
757 %       DEPOSIT0 DOMAIN%#S03%DOES%NOT%EXIST%IN%YOUR%DATABASE
758 %       WRITE
759 %       GOTO 77
⑧ 760 %       NOTE: EXTRACT DOMAIN SIZE FROM INDEX IGNORE FIELD 2
761 %       #GINP=#GCCT+2
762 %       CALLVSTR(#LV1,0,,)
763 %       #GINP=#GINP+#GCCT+1
764 %       CALLVSTR(#LSIZE,0,,)
765 %       NOTE: CONVERT SIZE AND ADD TO GROUP SIZE COUNT
766 %78     CALLCONV(#LSIZE,#LSIZE)
767 %       #LCHCT=#LCHCT+#LSIZE
⑨ 768 %       NOTE: GENERATE LEVEL 03 STATEMENT
769                 03 #S09 PICTURE X(#LSIZE).
770 %       MAINFILE,GWAC132-DAT1
771 %       SAVE,1,TEMPITEM
⑩ 772 %       NOTE: GENERATE MOVE STATEMENT
773 %       LABELOFF
774             MOVE #S03 IN Z-TUPLE TO #S03 IN
775             #S09 IN Z-TUPLE.
776 %       LABELON
777 %       SAVE,1,CONCAT
778 %       MAINFILE,GWAC132-DATA
779 %       NOTE: TEST FOR FIRST TIME
780 %       IF #LWORD.NE.'FIRST',GOTO 79
781 %       NOTE: SET WORD TO 'NEXT'
782 %       #LWORD='NEXT'
783 %       GOTO 76
⑪ 784 %       NOTE: ASK IF CURRENT CONCATENATION COMPLETE
785 %79     DEPOSIT0 HAVE%YOU%ANY%MORE%DOMAINS%TO%INCLUDE%IN%THIS%CONCATENATIS
786 %       CALLCOPY(57,ON?)
787 %       WRITE
788 %       CALL 2200
789 %       NOTE: READ AND VALIDATE REPLY
790 %80     CALL 9000
791 %       SQUASH
792 %       IF #GSTC.GT.1,GOTO 80
793 %       CALLFSTR(#LV1,1,1)
794 %       IF #LV1.IN.'N',GOTO 82
795 %       IF #LV1.EQ.'Y',GOTO 76
796 %       NOTE: INVALID RESPONSE
797 %       OBEY 2100,80
798 %       NOTE: ENTER DOMAIN IN INDEX AND UPDATE COUNT
799 %82     RESET #S01
800 %       DEPOSIT1 #S02,E,#LCHCT,A,,0,,N,S
801 %       INSERT #LDMPT,#S01
802 %       #GDMCT=#GDMCT+1
⑫ 803 %       NOTE: WRITE COMPOUND DOMAIN MESSAGE
804 %       DEPOSIT0 COMPOUND%DOMAIN#S09%CONTAINS%#LCHAR%CHARACTERS%AND%ISS
805 %       WRITE
806 %       DEPOSIT0 ALPHANUMERIC%IN%TYPE.
807 %       WRITE
⑬ 808 %       DEPOSIT0 HAVE%YOU%ANY%MORE%COMPOUND%DOMAINS%TO%CREATE?S
809 %       GOTO 20
810 %       NOTE: GENERATE FINAL STATEMENTS FOR CONCAT AND TEMPITEM MACROS
811 %90     MAINFILE,GWAC132-DAT1
812             010     LABELON
```

24. STAGE5-2 SUBFILE

```
677 %9999 CONTINUE
678 %END
679 ********
680 INPUT
681 STAGE5-2
682 %DEF  STAGE5-200
683 %     NOTE: SAVE PREVIOUSLY GENERATED TEMPITEM STATEMENTS
684 %     MAINFILE,GWAC132-DAT1
685 %     SAVE,0,TEMPITEM
686 %     NOTE: GENERATE FIRST STATEMENTS FOR CONCAT MACRO
687       @10DEF  CONCAT
688       @10     LABELOFF
689       SAVE,0,CONCAT
690 %     MAINFILE,GWAC132-DAT1
691 %     NOTE: OFFER USER OPTION TO CONCATENATE DATA ITEMS
692 %     NOTE: PRINT INTRODUCTORY DIALOGUE
693 %     SELECT DIAL5
694 %     #LLINE=11
695 %91   FREAD #LLINE,#S01
696 %     DEPOSITO #S01$
697 %     WRITE
698 %     #LLINE=#LLINE+1
699 %     IF #LLINE.LE.16,GO TO 91
700 %     DEPOSITO DO%YOU%WISH%TO%TEMPORARILY%EXTEND%YOUR%DATABASE%BY%THE$
701 %     WRITE
702 %     DEPOSITO INCLUSION%OF%A%COMPOUND%DOMAIN?$
703 %20   WRITE
704 %     CALL 2200
705 %     NOTE: READ AND VALIDATE REPLY
706 %70   CALL 9000
707 %     SQUASH
708 %     IF #GSTC.GT.1,GOTO 71
709 %     CALL FSTR(#LV1,1,1)
710 %     IF #LV1.IN.'N',GOTO 90
711 %     IF #LV1.EQ.'Y',GOTO 72
712 %     NOTE: INVALID RESPONSE
713 %71   OBEY 2100,70
714 %     NOTE: REQUEST NAME
715 %72   DEPOSITO PLEASE%TYPE%THE%NAME%OF%THE%COMPOUND%DOMAIN%WHICH%YOU%WIS
716 %     CALLCOPY(57,SH%TO%CREATE.)
717 %     WRITE
718 %     NOTE: READ AND VALIDATE NAME
719 %74   CALL 9000
720 %     WRITE #S09
721 %     #LLNG=14
722 %     CALL 200
723 %     IF #LNERR.EQ.0,GOTO 73
724 %     DEPOSITO #S09%IS%AN%INVALID%NAME%FOR%REASON%LISTED%ABOVE.$
725 %     WRITE
726 %     GOTO 74
727 %     NOTE: BINARY SEARCH DOMAININDEX FOR DUPLICATE NAME
728 %73   CALL 8000
729 %     IF #LIND.EQ.0,GOTO 75
730 %     DEPOSITO DOMAIN%#S09%ALREADY%EXISTS!%PLEASE%THINK%OF%A%NEW%NAME.$
731 %     WRITE
732 %     GOTO 74
733 %     NOTE: SAVE INDEX POINTER
734 %75   #LDMPT=#LL00
735 %     NOTE: INITIALISE COUNT OF CHARACTERS
736 %     #LCHCT=0
737 %     NOTE: GENERATE LEVEL 02 ENTRY
738             02 #S09
739 %     MAINFILE,GWAC132-DAT1
740 %     SAVE,1,TEMPITEM
741 %     MAINFILE,GWAC132-DATA
742 %     NOTE: ASK FOR CONSTITUENT DOMAIN ITEMS
743 %     #LWORD='FIRST'
744 %     DEPOSITO ITEMS%FROM%THE%DOMAINS%WHICH%YOU%ARE%ABOUT%TO%SPECIFY$
```

```
473 %       IF #LV1.EQ.'Y',GOTO 72
474 %       NOTE: INVALID RESPONSE
475 %70     OBEY 2100,59
476 %       NOTE: TOTALS NOT REQUIRED
477 %71     #LTOT='E'
478 %       GOTO 53
479 %       NOTE: TOTALS REQUIRED
480 %72     #GTOT=1
481 %       #LTOT='S'
⑦ 482 %     NOTE: ENTER DOMAIN NUMBER INDEX AND UPDATE DOMAIN COUNT
483 %53     RESET #S02
484 %       DEPOSIT2 #S09,#LTOT,#LSIZE,N,#LDIR#LSHFT,0,,N,S
485 %       INSERT #LLOU,#S02
486 %       #GDMCT=#GDMCT+1
⑧ 487 %     NOTE: GENERATE LEVEL 02 ENTRY FOR NUMERIC ITEM
488 %       IF #LSHFT.EQ.0,GOTO 60
489 %       IF #LDIR.EQ.'R',GOTO 61
490 %       IF #LSHFT.GT.#LSIZE,GOTO 62
491 %       #LV4=#LSIZE-#LSHFT
492 %       IF #LV4.EQ.0,GOTO 64
493 %       LABELOFF
494             02 #S09 PICTURE S9(#LV4)V9(#LSHFT) COMPUTATIONAL VALUE
495 %       LABELON
496 %       GOTO 63
497 %60     LABELOFF
498             02 #S09 PICTURE S9(#LSIZE) COMPUTATIONAL VALUE
499 %       LABELON
500 %       GOTO 63
501 %61     LABELOFF
502             02 #S09 PICTURE S9(#LSIZE)P(#LSHFT)V COMPUTATIONAL VALUE
503 %       LABELON
504 %       GOTO 63
505 %62     #LV4=#LSHFT-#LSIZE
506 %       LABELOFF
507             02 #S09 PICTURE SVP(#LV4)9(#LSIZE) COMPUTATIONAL VALUE
508 %       LABELON
509 %       GOTO 63
510 %64     LABELOFF
511             02 #S09 PICTURE SV9(#LSIZE) COMPUTATIONAL VALUE
512 %       LABELON
513 %63     LABELOFF
514             #S01.
515 %       LABELON
⑨ 516 %     NOTE: ASK IF MORE NUMERIC ITEMS
517 %       DEPOSIT0 HAVE%YOU%ANY%MORE%TEMPORARY%NUMERIC%ITEMS%TO%CREATE?$
518 %       GOTO 10
519 %       NOTE: CHAIN TO NEXT STAGE
520 %56     CONTINUE
521             [CHAIN0,STAGE5-2]
522             [STAGE5-201@]
523 %       GOTO 9999
524 %       NOTE: ROUTINE TO VALIDATE A NUMERIC LITERAL - MAX SIZE 60 CHARS.
525 %8100   SQUASH
526 %       IF #GSTC.LT.1,GOTO 8101
527 %       IF #GSTC.GT.60,GOTO 8101
528 %       #GINP=1
529 %8102   CALLFSTR(#LV1,0,1)
530 %       IF #LV1.IN.'+-',GOTO 8103
531 %       TESTDIGT(#LV1)
532 %       IF #GTST.EQ.1,GOTO 8104
533 %       IF #LV1.EQ.'.',GOTO 8105
534 %8101   DEPOSIT0 INVALID%LITERAL,%A%SIGN%IF%PRESENT,%MUST%BE%THE%FIRST%C$
535 %       CALLCOPY(57,HARACTER,%ALL)
536 %       WRITE
537 %       DEPOSIT0 OTHER%CHARACTERS,%APART%FROM%THE%DECIMAL%POINT,%MUST%BE%$
538 %       CALLCOPY(57,DIGITS.0THE)
539 %       WRITE
540 %       DEPOSIT0 DECIMAL%POINT%MAY%NOT%BE%THE%LAST%CHARACTER.%THE%MAXIMUM$
```

```
405 %     NOTE: REQUEST DISPLACEMENT
406 %45   DEPOSITO PLEASE%TYPE%THE%NUMBER%OF%DIGIT%POSITIONS%THE%DECIMAL%POS
407 %     CALLCOPY(57,IT%IS%DISPLACED)
408 %     WRITE
409 %     DEPOSITO TO%THE%#LDIR%OF%THE%RIGHTMOST%DIGIT.%DEFAULT%REPLY%IS%0$
410 %     WRITE
411 %     NOTE: READ AND VALIDATE REPLY
412 %47   CALL 9000
413 %     SQUASH
414 %     IF #GSTC.GT.1,GOTO 48
415 %     CALLFSTR(#LSHFT,1,1)
416 %     IF #LSHFT.EQ.' ',GOTO 57
417 %     TESTDIGT(#LSHFT))
418 %     IF #GIGT.NE.0,GOTO 48
419 %     CALLCONV(#LSHFT,#LSHFT)
420 %     GOTO 46
421 %57   #LSHFT=0
422 %     GOTO 46
423 %     NOTE. INVALID REPLY
424 %48   DEPOSIT1 DISPLACEMENT%MUST%BE%IN%THE%RANGE%1%TO%9$
425 %     WRITE
426 %     GOTO 47
427 %     NOTE: REQUEST INITIAL VALUE
428 %46   DEPOSITO DO%YOU%WISH%TO%ENTER%AN%INITIAL%VALUE%FOR%#S09?$
429 %     WRITE
430 %     CALL 2200
431 %     DEPOSITO BY%DEFAULT%THE%ITEM%WILL%INITIALLY%CONTAIN%ZERO.$
432 %     WRITE
433 %     NOTE: READ AND VALIDATE REPLY
434 %49   CALL 9000
435 %     SQUASH
436 %     IF #GSTC.GT.1,GOTO 50
437 %     CALLFSTR(#LV1,1,1)
438 %     RESET #S01
439 %     IF #LV1.IN.'N ',GOTO 51
440 %     IF #LV1.EQ.'Y',GOTO 52
441 %     NOTE: INVALID RESPONSE
442 %     OBEY 2100,60
443 %     NOTE. DEFAULT VALUE OF ZERO SET
444 %51   DEPOSIT1 0$
445 %     GOTO 58
446 %     NOTE: REQUEST INITIAL VALUE
447 %52   DEPOSITO PLEASE%ENTER%THE%INITIAL%VALUE%FOR%#S09.$
448 %     WRITE
449 %     DEPOSITO THE%VALUE%MUST%CONSIST%OF%DIGITS%AND%MAY%INCLUDE%A%DECIM$
450 %     CALLCOPY(57,AL%POINT,%WHICH)
451 %     WRITE
452 %     DEPOSITO MAY%NOT%BE%THE%LAST%CHARACTER.%THE%SIGN,%IF%PRESENT,%MUS$
453 %     CALLCOPY(57,T%BE%THE%FIRST)
454 %     WRITE
455 %     DEPOSITO CHARACTER,%BY%DEFAULT%THE%SIGN%IS%POSITIVE.$
456 %     WRITE
457 %     NOTE: READ AND VALIDATE REPLY
458 %54   CALL 9000
459 %     CALL 8100
460 %     NOTE: STORE LITERAL
461 %     WRITE #S01
462 %     NOTE: ASK IF TOTALS REQUIRED
463 %58   DEPOSITO DO%YOU%WISH%THE%SYSTEM%TO%ACCUMULATE%A%TOTAL%FOR%THIS$
464 %     CALLCOPY(55,%ITEM?)
465 %     WRITE
466 %     CALL 2200
467 %     NOTE: READ AND VALIDATE USERS REPLY
468 %59   CALL 9000
469 %     SQUASH
470 %     IF #GSTC.GT.1,GOTO 70
471 %     CALLFSTR(#LV1,1,1)
472 %     IF #LV1.IN.' N',GOTO 71
```

```
      %      IF #GROUP.NE.'Y',GOTO 1
⑥     %      NOTE: PRINT MESSAGE DIALOGUE
      %      #LLINE=14
      %      #LLAST=17
      %10    CALL 2000
⑦     %      NOTE: READ AND VALIDATE RESPONSE
      %      SQUASH
      %      IF #GSTC.GT.1,GOTO 11
      %      CALLFSTR(#LV1,1,1)
      %      IF #LV1.IN.'0S ',GOTO 12
      %      NOTE: INVALID RESPONSE
      %11    OBEY 2100,10
      %12    RESET #S05
      %      IF #LV1.EQ.'0',GOTO 13
      %      NOTE: SYSTEM MESSAGE
      %      DEPOSIT5 HIS-MATCHS
      %      GOTO 1
⑧     %      NOTE: REQUEST USERS MESSAGE
      %13    DEPOSITO PLEASE%TYPE%YOUR%MESSAGE.%CHARACTER%IN%EXCESS%OF%20%WILLS
      %      CALLCOPY(57,%BE%IGNORED)
      %      WRITE
      %      CALL 9000
      %      WRITE #S05
      %      GOTO 1
      %      NOTE, ROUTINE TO PRINT DIALOGUE FROM DIAL6 FILE
      %2000  SELECT DIAL6
      %2001  FREAD #LLINE,#S01
      %      DEPOSITO #S01S
      %      WRITE
      %      #LLINE=#LLINE+1
      %      IF #LLINE.LE.#LLAST,GOTO 2001
      %      EXIT
      %      NOTE, PRINT INVALID RESPONSE MESSAGE
      %2100  DEPOSITO INVALID%RESPONSE.$
      %      WRITE
      %      RETURN
      %      NOTE, ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
      %9000  DEPOSITO :$
      %      WRITE
      %      READ
      %      CALLFSTR(#LV1,1,5)
      %      IF #LV1.EQ.'%HELP',GOTO 9001
      %      EXIT
      %9001  MAINFILE,GWAC132-DATA
             [CHAIN0,HELP]
             [HELP@10]
      %      GOTO 9999
⑨     %      NOTE: CHAIN TO STAGE7
      %1     CONTINUE
             [CHAIN0,STAGE7]
             [STAGE7@10]
      %9999  CONTINUE
      %END
      ********
      INPUT
      DIAL7
      STAGE 7 - SELECTION OF DATA FOR RETRIEVAL.
      YOU ARE ABOUT TO SPECIFY THE CONDITION(S) WHICH MUST BE SATISFIED BEFORE
      THE DATA IS SELECTED FOR RETRIEVAL FROM THE DATA BASE.
      CONDITIONS MAY BE SIMPLE OR COMPOUND. A COMPOUND CONDITION IS MADE UP OF
      SEVERAL SIMPLE CONDITIONS LINKED BY THE CONJUNCTIONS AND/OR. THE SYSTEM
      WILL PROMPT YOU TO BUILD UP COMPOUND CONDITIONS IN TERMS OF SIMPLE
      CONDITIONS.
      EACH SIMPLE CONDITION CONSISTS OF THREE PARTS:
      TWO OPERANDS SEPARATED BY AN OPERATOR.
      THE FIRST OPERAND IS THE NAME OF THE DOMAIN TO WHICH THE ITEMS TO BE
      TESTED BELONG.
      THE SECOND OPERAND SPECIFIES WITH WHAT THE FIRST OPERAND MUST BE
```

26. DIAL7 AND STAGE7 SUBFILES

25. DIAL6 AND STAGE6 SUBFILES

```
GWAC132-DAT1
52UNIVST
INPUT
DIAL6
STAGE 6 - DATABASE INCONSISTENCES
YOUR PROBLEM MAKES USE OF MORE THAN ONE RELATION. IF, WHEN THE RELATIONS
ARE JOINED, A DATA INCONSISTENCY IN A DOMAIN USED AS A SEQUENCE KEY IS
DETECTED BY THE SYSTEM SUCH THAT THERE IS NOT A MATCHING KEY ITEM FOR
ALL RELATIONS, WHICH ONE OF THE FOLLOWING ACTIONS DO YOU WISH THE SYSTEM
TO TAKE?
1    IGNORE THE UNMATCHED ITEMS AND CONTINUE WITH THE NEXT DATA RETRIEVAL
2    CREATE DUMMY MATCHING KEY ITEMS AND CONTINUE PROCESSING ON THE
     ASSUMPTION THAT ALL NUMERIC NON-KEY ITEMS CONTAIN ZEROS AND ALL
     ALPHANUMERIC NON-KEY ITEMS CONTAIN BLANKS.
3    TERMINATE THE PROCESSING OF THE DATABASE.
     ----------------------------------------
PLEASE TYPE 1,2 OR 3. THE DEFAULT REPLY IS 1.
THE SYSTEM WILL PRINT THE RELATION NAME AND THE VALUE OF THE UNMATCHED
KEY TOGETHER WITH THE MESSAGE "MIS-MATCH". ALTERNATIVELY YOU MAY SPECIFY
YOUR OWN MESSAGE OF UP TO 20 CHARACTERS. PLEASE TYPE S FOR SYSTEM
MESSAGE OR O FOR OWN. THE DEFAULT REPLY IS SYSTEM.
********
INPUT
STAGE6
%DEF   STAGE600
%      NOTE: DATABASE INCONSISTENCIES - CHECK POINT 6
(1) %  NOTE: SET CHECK POINT NO.
%      #GCKPT=6
(2) %  NOTE: TEST FOR ONLY 1 RELATION
%      IF #GNREL.EQ.1,GOTO 1
(3) %  NOTE: PRINT INTRODUCTORY DIALOGUE FOR STAGE6
%      #LINE=1
%      #LEAST=13
%      CALL 2000
(4) %  NOTE: READ AND VALIDATE RESPONSE
%4     CALL 9000
%      SQUASH
%      IF #GSTC.GT.1,GOTO 3
%      CALLFSTR(#GOPT,1,1)
%      IF #GOPT.IN.'123',GOTO 5
%      NOTE: INVALID RESPONSE
%3     OBEY 2100,4
%      NOTE: SET OPTION CODE
%5     IF #GOPT.NE.' ',GOTO 6
%      #GOPT='1'
%6     CALLCONV(#GOPT,#GOPT)
(5) %  NOTE: OFFER USER MESSAGE OPTION
%      DEPOSITO DO%YOUQUANT%THE%SYSTEM%TO%PRINT%A%MESSAGE%WHEN%A%MIS-MATS
%      CALLCOPY(57,CH%CONDITION%IS)
%      WRITE
%      DEPOSITO DETECTED?%PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO.%THE%DEFAULTS
%      CALLCOPY(57,%REPLY%IS%NO.)
%      WRITE
%      NOTE: READ AND VALIDATE RESPONSE
%7     CALL 9000
%      SQUASH
%      IF #GSTC.GT.1,GOTO 8
%      CALLFSTR(#GMOP,1,1)
%      IF #GMOP.IN.'YN',GOTO 9
%      NOTE: INVALID RESPONSE
%8     OBEY 2100,7
%      NOTE: TEST OPTION
%9     IF #GMOP.NE.'Y',GOTO 1
%      NOTE: TEST OPTION
```

```
881 %       GOTO 210
882 %       NOTE: FIRST CHARACTER HYPHEN OR Z
883 %204    DEPOSITO Z%OR%HYPHEN%NOT%ALLOWED%AS%FIRST%CHARACTERS
884 %       WRITE
885 %       #LNERR=1
886 %       GOTO 211
887 %       NOTE: LAST CHARACTER HYPHEN
888 %205    DEPOSITO HYPHEN%NOT%ALLOWED%AS%LAST%CHARACTERS
889 %       WRITE
890 %       #LNERR=1
891 %       GOTO 212
892 %       NOTE: ADD 1 TO ALPHABETIC COUNT
893 %207    #LALPH=#LALPH+1
894 %       GOTO 206
895 %       NOTE: ROUTINE TO SEARCH DOMAININDEX FOR THE DOMAIN NAME CONTAINED
896 %       NOTE: IN #S09
897 %       NOTE: DOMAIN COUNT = #GDNCT
898 %       NOTE: #LIND = INDICATOR 0=FOUND 1=NOT FOUND
899 %8000   #LIND=0
900 %       SELECT DOMAININDEX
901 %       #LLOW=1
902 %       #LHIGH=#GDNCT
903 %       IF #LLOW.GT.#LHIGH,GOTO 8001
904 %       #LCUR=#LLOW+#LHIGH
905 %       #LCUR=#LCUR/2
906 %       FREAD #LCUR,#S01
907 %       NOTE: EXTRACT DOMAIN NAME
908 %       VSTR2 #S01;1,,
909 %       IF #S02.GT.#S09,GOTO 8002
910 %       IF #S02.LT.#S09,GOTO 8003
911 %8004   EXIT
912 %8001   #LIND=1
913 %       GOTO 8004
914 %8002   #LHIGH=#LCUR-1
915 %       GOTO 8005
916 %8003   #LLOW=#LCUR+1
917 %       GOTO 8005
918 %       NOTE: PRINT INVALID RESPONSE MESSAGE
919 %2100   DEPOSITO INVALID%RESPONSE.$
920 %       WRITE
921 %       RETURN
922 %       NOTE: PRINT PLEASE TYPE MESSAGE
923 %2200   DEPOSITO PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO.%THE%DEFAULT%REPLY%IS%$
924 %       CALLCOPY(57,NO.)
925 %       WRITE
926 %       EXIT
927 %       NOTE: ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
928 %9000   DEPOSITO :$
929 %       WRITE
930 %       READ
931 %       CALLVSTR(#LV1,1,5)
932 %       IF #LV1.EQ.'%HELP',GOTO 9001
933 %       EXIT
934 %       CONTINUE
935 %       [CHAINO,HELP]
936 %       [HELP]
937 %9999   CONTINUE
938 %END
939 ********
940 FINISH

**** END OF STREAM  GWAC132      953
```

```
813                @10END
814 %              SAVE,1,CONCAT
815                @1@      LABELON
816                @10END
817 %              SAVE,1,TEMPITEM
818 %              NOTE: CHAIN TO NEXT STAGE
819 %              CONTINUE
820                [CHAIN0,STAGE6]
821                [STAGE6010]
822 %              GOTO 9800
823 %              NOTE: VALIDATE NAME STARTING IN 1ST POSITION OF INPUT BUFFER
824 %              NOTE: #LNERR = ERROR INDICATOR - INITIALL CLEARED TO ZERO
825 %200           #LNERR=0
826 %              NOTE: TEMPORARILY SAVE CONTENTS OF INPUT BUFFER
827 %              WRITE #S01
828 %              SQUASH
829 %              NOTE: CHECK NO. OF CHARACTERS KEYED
830 %              IF #GSTC.GT.#LLEUG,GOTO 202
831 %              NOTE: CHECK FOR IMBEDDED BLANKS
832 %209           WRITE #S02
833 %              IF #S02.NE.#S01,GOTO 203
834 %              NOTE: CHECK FIRST CHARACTER FOR HYPHEN OR Z
835 %210           CALLFSTR(#LV1,1,1)
836 %              IF #LV1.IN.'-Z',GOTO 204
837 %              NOTE: CHECK LAST CHARACTER FOR HYPHEN
838 %211           #GINP=#GSTC
839 %              CALLFSTR(#LV1,0,1)
840 %              IF #LV1.EQ.'-',GOTO 205
841 %              NOTE: SET UP LOOP TO CHECK FOR ALPHABETIC, NUMERIC AND HYPHEN ONLY
842 %212           #GINP=1
843 %              NOTE: ZEROISE COUNT OF ALPHA CHARACTERS
844 %              #ALPH=0
845 %              NOTE: EXTRACT NEXT CHARACTER
846 %213           CALLFSTR(#LV1,0,1)
847 %              NOTE: TEST NUMERIC
848 %              TESTDIGT(#LV1)
849 %              IF #GTST.EQ.0,GOTO 206
850 %              NOTE: TEST ALPHABETIC
851 %              TESTLETR(#LV1)
852 %              IF #GTST.EQ.0,GOTO 207
853 %              NOTE: TEST HYPHEN
854 %              IF #LV1.EQ.'-',GOTO 206
855 %              NOTE: INVALID CHARACTER FOUND
856 %              DEPOSITO #LV1%INVALID%CHARACTER.%ONLY%A%TO%Z,%0%TO%9%AND%-%ALLOWE$
857 %              CALLCOPY(54,D)
858 %              WRITE
859 %              NOTE: SET ERROR INDICATOR ON
860 %              #LNERR=1
861 %              NOTE: UPDATE POINTER AND TEST FOR END OF LOOP
862 %206           #GINP=#GINP+1
863 %              IF #GINP.GT.#GSTC,GOTO 214
864 %              GOTO 213
865 %              NOTE: TEST FOR AT LEAST ONE ALPHA CHARACTER
866 %214           IF #ALPH.GT.0,GOTO 208
867 %              NOTE: NO ALPHA CHARACTER PRESENT
868 %              DEPOSITO AT%LEAST%ONE%ALPHABETIC%CHARACTER%MUST%BE%INCLUDED$
869 %              WRITE
870 %              #LNERR=1
871 %208           EXIT
872 %              NOTE: NAME TOO LONG
873 %202           DEPOSITO MORE%THAN%#LLENG%CHARACTERS%IN%NAME$
874 %              WRITE
875 %              #LNERR=1
876 %              GOTO 209
877 %              NOTE: BLANKS NOT ALLOWED
878 %              DEPOSITO BLANKS%NOT%ALLOWED$$
879 %              WRITE
880 %              #LNERR=1
```

```
201 %       WRITE
202 %       NOTE: PROCESS CONDITIONS
203 %       CALL 7000
204 %       NOTE: GENERATE ACTION STATEMENTS
205                   GO TO Z-PARA-4, GO TO Z-PARA-5.
206 %       GOTO 3
207 %       NOTE: ROUTINE TO VALIDATE REQUEST FOR CONDITIONAL PROCESSING
208 %       NOTE: GENERATE THE COBOL IF
209 %7000   CONTINUE
210                   IF
211 %       DEPOSITO DO%YOU%WISH%TO%SPECIFY%A%COMPOUND%CONDITION%FOR%THE%ABOVE$
212 %       CALLCOPY(57,E%TASK?)
213 %       WRITE
214 %       CALL 2200
215 %       NOTE: READ AND VALIDATE REPLY
216 %7001  CALL 9000
217 %       SQUASH
218 %       IF #GSTC.GT.1,GOTO 7002
219 %       CALLFSTR(#LV1,1,1)
220 %       IF #LV1.IN.' N',GOTO 7003
221 %       IF #LV1.EQ.'Y',GOTO 7004
222 %       NOTE: INVALID RESPONSE
223 %       OBEY 2100,7001
224 %       NOTE: REQUEST SIMPLE CONDITION
225 %7003  DEPOSITO PLEASE%TYPE%YOUR%SIMPLE%CONDITION.$
226 %       WRITE
227 %       NOTE: READ CONDITION
228 %       CALL 9000
229 %       NOTE: VALIDATE CONDITION
230 %       CALL 7100
231 %       IF #LERR.EQ.1,GOTO 7023
232 %7005  CONTINUE
233 %       EXIT
234 %       NOTE: INVALID CONDITION
235 %7023  DEPOSITO INVALID CONDITION FOR REASON SHOWN ABOVE$
236 %       WRITE
237 %       GOTO 7003
238 %       NOTE: COMPOUND CONDITION - PRINT DIALOGUE
239 %7004  #LWORD='FIRST'
240 %7012  DEPOSITO PLEASE%TYPE%YOUR%#LWORD%SIMPLE%CONDITION.$
241 %       WRITE
242 %       NOTE: READ AND VALIDATE CONDITION
243 %7006  CALL 9000
244 %       CALL 7100
245 %       IF #LERR.EQ.1,GOTO 7006
246 %       NOTE: CHECK FOR MORE CONDITIONS TO COME
247 %       IF #LWORD.EQ.'FIRST',GOTO 7013
248 %       DEPOSITO HAVE%YOU%ANY%MORE%CLAUSES%OF%YOUR%COMPOUND%CONDITION%TO%$
249 %       CALLCOPY(57,ENTER?)
250 %       WRITE
251 %       CALL 2200
252 %       NOTE: READ AND VALIDATE REPLY
253 %7014  CALL 9000
254 %       SQUASH
255 %       IF #GSTC.GT.1,GOTO 7015
256 %       CALLFSTR(#LV1,1,1)
257 %       IF #LV1.IN.' N',GOTO 7005
258 %       IF #LV1.EQ.'Y',GOTO 7015
259 %       NOTE: INVALID RESPONSE
260 %       OBEY 2100,7014
261 %       NOTE: CHANGE "FIRST" TO "NEXT"
262 %7013  #LWORD='NEXT'
263 %       NOTE: REQUEST CONJUNCTION
264 %7015  DEPOSITO IS%THE%CONJUNCTION%WHICH%PRECEDES%YOUR%NEXT%CONDITION%"A$
265 %       CALLCOPY(57,ND"%OR%"OR"?)
266 %       WRITE
267 %       DEPOSITO PLEASE%TYPE%A%FOR%"AND"%OR%O%FOR%"OR",%THE%DEFAULT%REPLY$
268 %       CALLCOPY(57,"AND")
```

```
133 COMPARED. IT MAY BE THE NAME OF A TEMPORARY ITEM, A LITERAL VALUE OR THE
134 NAME OF THE DOMAIN TO WHICH THE ITEM BEING COMPARED BELONGS.
135 IF YOU ENTER AN ALPHANUMERIC LITERAL AS THE SECOND OPERAND YOU MUST
136 ENCLOSE IT IN QUOTATION MARKS, E.G. "ALPHANUMERIC LITERAL".
137 THE OPERATOR SPECIFIES HOW THE COMPARISON BETWEEN THE FIRST AND SECOND
138 OPERANDS IS TO BE MADE DURING THE CONDITION TEST.
139 THE OPERATOR MUST BE ONE OF THE FOLLOWING:
140 OPERATOR      MEANING
141 .EQ.         EQUAL TO
142 .LT.         LESS THAN
143 .LE.         LESS THAN OR EQUAL TO
144 .GT.         GREATER THAN
145 .GE.         GREATER THAN OR EQUAL TO
146 .NE.         NOT EQUAL TO
147 THE FULL STOPS ARE AN INTEGRAL PART OF THE OPERATOR
148 YOU MAY NEGATE ANY OF THE ABOVE OPERATORS BY INCLUDING THE WORD NOT
149 IMMEDIATELY AFTER THE FIRST FULL STOP.
150 E.G.
151 .NOT GT. NOT GREATER THAN
152 HERE ARE SOME EXAMPLES OF SIMPLE CONDITIONS:
153 ACCOUNT-NO .LT. TRANSACTION-NUMBER
154 QTY-ON-HAND .NOT GT. 400
155 PART-NAME .EQ. "NAILS"
156 ********
157 INPUT
158 STAGE7
159 %DEF   STAGE700
160 %       NOTE: STAGE 7 - SELECTION OF DATA FOR RETRIEVAL
①161 %       NOTE: SET CHECK POINT NO.
②162 %       #GCKPT=7
163 %       NOTE: GENERATE FIRST STATEMENTS OF SELCOND MACRO
164         @1@DEF  SELCOND
165         @1@     LABELOFF
③166 %       NOTE: PRINT INTRODUCTORY DIALOGUE
167 %       DEPOSITO DO%YOU%WISH%TO%SELECT%ONLY%CERTAIN%ITEMS%FOR%RETRIEVAL%FS
168 %       CALLCOPY(57,ROM%THE%DOMAINS)
169 %       WRITE
170 %       DEPOSITO IN%YOUR%RELATION(S)?S
171 %       WRITE
172 %       CALL 2200
173 %       NOTE: READ AND VALIDATE REPLY
174 %1      CALL 2000
175 %       SQDASH
176 %       IF #GSTC.GT.1,GOTO 2
177 %       CALLFSTR(#LV1,1,1)
178 %       IF #LV1.IN.'N',GOTO 3
179 %       IF #LV1.EQ.'Y',GOTO 4
180 %       NOTE: INVALID RESPONSE
181 %2      OBEY 2100,1
⑦182 %       NOTE: GENERATE FINAL STATEMENTS FOR SELCOND MACRO AND SAVE
183 %3      CONTINUE
184         @1@     LABELON
185         @1@END
186 %       SAVE 0,SELCOND
187 %       NOTE: CHAIN TO STAGE 8
188 %       CONTINUE
189         [CHAIN0,STAGE8]
190         [STAGE8@1@]
191 %       GOTO 9999
④192 %       NOTE: PRINT SELECTION DIALOGUE
193 %       SELECT DIAL7
194 %       #LLINE=1
195 %4      FREAD #LLINE,#S01
196 %       DEPOSITO #S01S
197 %       WRITE
198 %       #LLINE=#LLINE+1
199 %       IF #LLINE.LE.44,GOTO 5
200 %       DEPOSITO DATA%RETRIEVAL.S
```

```
337 %        GOTO 7198
338 %        NOTE: VALIDATE OPERATOR
339 %7103    CALL$QUA #LOP
340 %        RESET #S08
341 %        IF 'NOT'.AT.#LOP,GOTO 7104
342 %        GOTO 7105
343 %        NOTE: NEGATED CONDITION
344 %7104    DEPOSIT8 NOT%$
345 %        RESET #S01
346 %        DEPOSIT1 #LOP$
347 %        READ #S01
348 %        #GOUP=#GSTC-3
349 %        IF #GOUP.NE.2,GOTO 7140
350 %        CALLFSTR(#LOP,4,0)
351 %        NOTE: IDENTIFY CONDITION
352 %7105    IF #LOP.EQ.'GT',GOTO 7106
353 %        IF #LOP.EQ.'LT',GOTO 7108
354 %        IF #LOP.EQ.'EQ',GOTO 7110
355 %        IF #LOP.EQ.'NE',GOTO 7112
356 %        IF #LOP.EQ.'LE',GOTO 7114
357 %        IF #LOP.EQ.'GE',GOTO 7116
358 %7140    DEPOSIT0 INVALID%OPERATOR
359 %        GOTO 7198
360 %7106    DEPOSIT8 GREATER%THAN$
361 %        GOTO 7118
362 %7108    DEPOSIT8 LESS%THAN$
363 %        GOTO 7118
364 %7110    DEPOSIT8 EQUAL%TO$
365 %        GOTO 7118
366 %7112    IF 'NOT'.AT.#S08,GOTO 7113
367 %        DEPOSIT8'NOT%EQUAL%TO$
368 %        GOTO 7118
369 %7113    RESET #S08
370 %        GOTO 7110
371 %7114    IF 'NOT' AT #S08,GOTO 7115
372 %        DEPOSIT8'NOT%GREATER%THAN$
373 %        GOTO 7118
374 %7115    RESET #S08
375 %        GOTO 7106
376 %7116    IF 'NOT'.AT.#S08,GOTO 7117
377 %        DEPOSIT8 NOT%LESS%THAN$
378 %        GOTO 7118
379 %7117    RESET #S08
380 %        GOTO 7108
381 %        NOTE: VALIDATE SECOND OPERAND
382 %        NOTE: SAVE TYPE FOR 1ST OPERAND
383 %7118    #LTYP1=#LTYPE
384 %        NOTE: SAVE LENGTH OF 2ND OPERAND
385 %        LEN4
386 %        #LL4=#GSIC
387 %        NOTE: TEST FOR ALPHANUMERIC LITERAL
388 %7119    RESET #S01
389 %        DEPOSIT1 #S04$
390 %        READ #S01
391 %        CALLFSTR(#LV1,1,1)
392 %        IF #LV1.NE.'"',GOTO 7122
393 %        NOTE: TEST FOR VALID LITERAL
394 %        IF #LL4.GE.3,GOTO 7120
395 %7121    DEPOSIT0 2ND%OPERAND%IS%AN%INVALID%ALPHANUMERIC%LITERAL.$
396 %        GOTO 7198
397 %        NOTE: CHECK FOR CLOSING QUOTE
398 %7120    #GOUP=#LL4
399 %        CALLFSTR(#LV1,0,1)
400 %        #GOUP=1
401 %        IF #LV1.EQ.'"',GOTO 7180
402 %        GOTO 7121
403 %        NOTE: TEST FOR NUMERIC LITERAL
404 %        NOTE: CLEAR DECIMAL PT INDICATOR
```

```
      %       WRITE
      %       NOTE: READ AND VALIDATE CONJUNCTION
      %7007   CALL 9000
      %       SQUASH
      %       IF #GSTC.GT.1,GOTO 7008
      %       CALLFSTR(#LV1,1,1)
      %       IF #LV1.IN.'A',GOTO 7009
      %       IF #LV1.EQ.'O',GOTO 7010
      %       NOTE: INVALID RESPONSE
      %       OBEY 2100,7007
      %       NOTE: AND CONJUNCTION
      %7009   CONTINUE
                          AND
      %       GOTO 7012
      %       NOTE: OR CONJUNCTION
      %7010   CONTINUE
                          OR
      %       NOTE: PRINT WARNING TO REPEAT CLAUSES
      %       DEPOSITO YOU%HAVE%SELECTED%THE%"OR"%CONJUNCTION,%BEFORE%YOU%ENTERS$
      %       CALLCOPY(57,%NEW%SIMPLE)
      %       WRITE
      %       DEPOSITO CONDITIONS%PLEASE%CONSIDER%IF%ANY%OF%THOSE%PREVIOUSLY%ENS$
      %       CALLCOPY(57,TERED%STILL)
      %       WRITE
      %       DEPOSITO APPLY%AND%IF%SO%RE-ENTER%THE%ONE%AT%A%TIME.$
      %       WRITE
      %       GOTO 7012
      %       NOTE: INVALID CONDITION
      %7016   DEPOSITO 'INVALID%CONDITION%FOR%REASON%SHOWN%ABOVE.$
      %       WRITE
      %       GOTO 7006
      %       NOTE: ROUTINE TO VALIDATE A CONDITION
      %       NOTE: CLEAR ERROR INDICATOR
      %7100   #LERR=0
      %       NOTE: EXTRACT 1ST OPERAND
      %       VSTR3,'1'
      %       IF #GFLA.EQ.1,GOTO 7101
      %       NOTE: 1ST FULL STOP MISSING
      %       DEPOSITO FULL%STOP%BEFORE%OPERATOR%MISSING$
      %7198   WRITE
      %       #LERR=1
      %       GOTO 7199
      %       NOTE: EXTRACT OPERATOR
      %7101   #GINP=#GCCT*6
      %       CALLVSTR(#LOP,0,,)
      %       IF #GFLA.EQ.1,GOTO 7102
      %       NOTE: 2ND FULL STOP MISSING
      %       DEPOSITO FULL%STOP%AFTER%OPERATOR%MISSING%OR%OPERATOR%INVALID.$
      %       WRITE
      %       GOTO 7198
      %       NOTE: EXTRACT 2ND OPERAND
      %7102   #GINP=#GINP+#GCCT+1
      %       #GOUP=72-#GINP
      %       IF #GINP.GE.72,GOTO 7136
      %       FSTR4 ,0,0
      %       NOTE: VALIDATE FIRST OPERAND
      %       RESET #S09
      %       DEPOSIT9 #S03$
      %       NOTE: CHECK DOMAININDEX FOR PRESENCE OF FIRST OPERAND
      %       MAINFILE,GUAC132-DATA
      %       CALL 8000
      %       MAINFILE,GUAC132-DAT1
      %       IF #LIND.EQ.0,GOTO 7103
      %       NOTE: FIRST OPERAND INVALID
      %       DEPOSITO #S03%IS%NOT%A%DOMAIN%IN%YOUR%DATABASE.$
      %       GOTO 7198
      %       NOTE: 2ND OPERATOR MISSING
      %7136   DEPOSITO 2ND%OPERATOR%MISSING$
```

```
423 %       SELECT DOMAININDEX
424 %       #LLOW=1
425 %       #LHIGH=#GDMCT
426 %8005  IF #LLOW.GT.#LHIGH,GOTO 8001
427 %       #LCUR=#LLOW+#LHIGH
428 %       #LCUR=#LCUR/2
429 %       FREAD #LCUR,#S01
430 %       NOTE: EXTRACT DOMAIN NAME
431 %       VSTR2 #S01,1
432 %       IF #S02.GT.#S00,GOTO 8002
433 %       IF #S02.LT.#S00,GOTO 8003
434 %       NOTE: DOMAIN FOUND - EXTRACT TYPE
435 %       #GINP=#GCCT+2
436 %       CALLFSTR(#LV1,0,,)
437 %       #GINP=#GINP+#GCCT+1
438 %       CALLVSTR(#LV1,0,,)
439 %       #GINP=#GINP+#GCCT+1
440 %       CALLFSTR(#LTYPE,0,1)
441 %8004  EXIT
442 %8001  #LIND=1
443 %       GOTO 8004
444 %8002  #HIGH=#LCUR-1
445 %       GOTO 8005
446 %8003  #LLOW=#LCUR+1
447 %       GOTO 8005
448 %       NOTE: ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
449 %9000  DEPOSITO :S
450 %       WRITE
451 %       READ
452 %       CALLVSTR(#LV1,1,5)
453 %       IF #LV1.EQ.'%HELP',GOTO 9001
454 %       EXIT
455 %9001  MAINFILE,GWAC132-DATA
456         [CHAIN0,HELP]
457         [HELP010]
458 %9999  CONTINUE
459 %END
460 ********
461 INPUT
462 DIAL8
463 STAGE 8 - REPORT LAYOUT INTRODUCTION
464 PLEASE CHOOSE YOUR PAGE WIDTH. A NARROW PAGE OF 70 CHARACTERS IS
465 SUITABLE FOR TELETYPE OR VDU OUTPUT. A WIDE PAGE OF 120 CHARACTERS
466 IS FOR LINE PRINTER OUTPUT. PLEASE TYPE N FOR NARROW OR W FOR WIDE.
467 THE DEFAULT REPLY IS NARROW.
468 WOULD YOU LIKE TO DESIGN THE FORMAT OF THE LINES OF YOUR REPORT OR WOULD
469 YOU PREFER ONLY TO SPECIFY WHICH ITEMS SHOULD BE INCLUDED IN THE OUTPUT
470 AND LEAVE THE SYSTEM TO ARRANGE THE EXACT FORMAT OF THE LINE(S)?
471 IF YOU DESIGN YOUR OWN LAYOUT, YOU MAY INCLUDE TEXT INFORMATION AS WELL
472 AS DATA ITEMS INCLUDING THE DATE, TIME AND PAGE NUMBER. YOU MAY ALSO
473 CONTROL THE SPACING OF LINES AND INSERT EDITING CHARACTERS INTO DATA
474 ITEMS TO IMPROVE THEIR PRESENTATION.
475 THE SYSTEM WILL ARRANGE THE ITEMS FOR OUTPUT IN THE REQUIRED ORDER
476 ACROSS THE LINE WITH TWO BLANK SPACES BETWEEN ITEMS. A NEW LINE WILL BE
477 TAKEN WHEN THERE IS INSUFFICIENT ROOM AT THE END OF A LINE FOR THE
478 COMPLETE ITEM. ALL OUTPUT ITEMS WILL BE UNEDITED.
479 DO YOU WISH TO SPECIFY THE FORMAT OF YOUR REPORT? PLEASE TYPE Y FOR YES
480 OR N FOR NO. THE DEFAULT REPLY IS NO.
481 YOU WILL SHORTLY BE ASKED TO DESIGN THE LINES WHICH COMPRISE THE TITLES,
482 HEADINGS AND DETAIL LINES OF YOUR REPORT. TO ASSIST WITH THIS THE NAMES
483 OF YOUR DATA DOMAINS AND TEMPORARY ITEMS WILL BE DISPLAYED TO YOU ONE AT
484 A TIME. YOU ARE THEN REQUIRED TO SELECT A ONE CHARACTER LABEL FROM THE
485 LIST SHOWN BELOW FOR USE LATER WHEN INDICATING THE PRINT POSITIONS OF
486 THE ITEM IN QUESTION. THE FOLLOWING CHARACTERS ARE VALID LABELS:
487 A B F G H I J K L N O Q T U V W X Z
488 YOU WILL HAVE NOTICED THAT NOT ALL ALPHABETIC CHARACTERS ARE AVAILABLE
489 FOR USE AS DATA LABELS. THIS IS BECAUSE SOME OF THEM HAVE SPECIAL
490 MEANINGS ASSOCIATED WITH EDITING DATA ITEMS PRIOR TO PRINTING. THE
```

27. DIAL8 AND STAGE8 SUBFILES

```
405 %7122 #LDCPT=0
406 %      IF #LV1.IN.'*=',GOTO 7123
407 %      IF #LV1.NE.'.',GOTO 7126
408 %      NOTE: CLEAR POINT INDICATOR
409 %7123 #LDCPT=0
410 %      GOTO 7125
411 %      NOTE: SET DECIMAL INDICATOR
412 %7124 #LDCPT=1
413 %      NOTE: CHECK LENGTH
414 %7125 IF #LL4.LE.1,GOTO 7130
415 %      #GINP=2
416 %      GOTO 7127
417 %7126 #GINP=1
418 %      NOTE: EXTRACT NEXT CHARACTER
419 %7127 CALLFSTR(#LV1,0,1)
420 %      NOTE: TEST FOR DIGIT
421 %      TESTDIGT(#LV1)
422 %      IF #GTST.EQ.1,GOTO 7128
423 %      IF #LV1.NE.'.',GOTO 7129
424 %      NOTE: CHECK FOR PREVIOUS POINT
425 %      IF #LDCPT=1,GOTO 7130
426 %      #LDCPT=1
427 %      IF #GINP.GE.#LL4,GOTO 7130
428 %      GOTO 7131
429 %      NOTE: CHECK FOR END OF LITERAL
430 %7128 IF #GINP.GE.#LL4,GOTO 7132
431 %7131 #GINP=#GINP+1
432 %      GOTO 7127
433 %      NOTE: INVALID NUMERIC LITERAL
434 %7130 DEPOSITO 2ND%OPERAND%IS%AN%INVALID%NUMERIC%LITERAL.$
435 %      GOTO 7198
436 %      NOTE: TEST COMPATIBILITY OF OPERAND TYPES
437 %7134 DEPOSITO OPERANDS%MUST%BE%OF%THE%SAME%TYPE,%EITHER%BOTH$
438 %      WRITE
439 %      DEPOSITO NUMERIC%OR%BOTH%ALPHANUMERIC.$
440 %      WRITE
441 %      GOTO 7198
442 %      NOTE: CHECK 2ND OPERAND FOR A VALID DOMAIN NAME
443 %7129 WRITE #S09
444 %      MAINFILE,GWAC132-DATA
445 %      CALL 8000
446 %      MAINFILE GWAC132-DAT1
447 %      IF #LIND.NE.0,GOTO 7133
448 %      DEPOSITO 2ND%OPERAND%IS%AN%INVALID%DOMAIN%NAME.$
449 %      GOTO 7198
450 %      NOTE: TEST COMPATIBILITY OF OPERAND TYPES
451 %      IF #LTYP1.NE.#LTYPE,GOTO 7135
452 %      NOTE: QUALIFY NAME OF 2ND OPERAND
453 %7135 DEPOSIT4 %IN%Z-TUPLE$
454 %      NOTE: GENERATE COBOL STATEMENT
455 %7180 LABELOFF
456 %           #S03 IN Z-TUPLE #S08
457 %           #S04
458 %      LABELON
459 %7199 EXIT
460 %      NOTE: PRINT INVALID RESPONSE MESSAGE
461 %2100 DEPOSITO INVALID%RESPONSE.$
462 %      WRITE
463 %      RETURN
464 %      NOTE: PRINT PLEASE TYPE MESSAGE
465 %2200 DEPOSITO PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO.%THE%DEFAULT%REPLY%IS%$
466 %      CALLCOPY(57,NO.)
467 %      WRITE
468 %      EXIT
469 %      NOTE: ROUTINE TO SEARCH DOMAININDEX FOR THE DOMAIN NAME IN #S09
470 %      NOTE: DOMAIN COUNT= #GDICT
471 %      NOTE: #LIND = INDICATOR 0=FOUND 1=NOT FOUND
472 %8000 #LIND=0
```

```
627 %       DEPOSIT1 #LV1#S01,#LV2,#LV4,$
678 %       REPLACE #LLPT,#S01
679 %       NOTE: UPDATE DOMAININDEX POINTER
680 %18     #LDIPT=#LDIPT+1
681 %       IF #LDIPT.GT.#GDMOT,GOTO 20
682 %       NOTE: CHECK IF ALL LABELS USED
683 %       IF #GSTC.GE.1,GOTO 14
684 %       NOTE:
685 %       DEPOSIT0 ALL%AVAILABLE%LABEL%CHARACTERS%USED.%NO%MORE%DOMAINS%CANS
686 %       WRITE
687 %       DEPOSIT0 APPEAR%IN%YOUR%REPORT.$
688 %       WRITE
689 %       GO TO 24
690 %       NOTE: COPY UNUSED LABEL RECORDS
691 %20     SELECT LABELTABLE
692 %21     READ #S04
693 %       CALLFSTR(#GUAS,0,1)
694 %       VSTR1 #S03,1,0
695 %       #LLPT=#GCCT+1
696 %       RESET #S01
697 %       DEPOSIT1 #LV1,,,$
698 %       REPLACE #LLPT,#S01
699 %       CALLSWAP(#S04,#LV1, )
700 %       SQUASH4
701 %       IF #GSTC.NE.0,GOTO 21
702 %       NOTE: PRINT REMAINING INSTRUCTIONAL TEXT
703 %24     #LLINE=38
704 %       #LSTOP=64
705 %       CALL 5000
706 %       NOTE: CHAIN TO NEXT STAGE
707 %       CONTINUE
708         [CHAINO,STAGE9]
709         [STAGE9,1a]
710 %       GOTO 9999
711 %       NOTE: PRINT INVALID RESPONSE MESSAGE
712 %2100   DEPOSIT0 INVALID%RESPONSE.$
713 %       WRITE
714 %       RETURN
715 %       NOTE: ROUTINE TO PRINT SELECTED DIALOGUE
716 %5000   SELECT DIAL8
717 %5001   FREAD #LLINE,#S01
718 %       DEPOSIT0 #S01$
719 %       WRITE
720 %       #LLINE=#LLINE+1
721 %       IF #LLINE.LE.#LSTOP,GOTO 5001
722 %       EXIT
723 %       NOTE: ROUTINE TO READ A RESPONSE AND DETECT A PLEA FOR HELP
724 %9000   DEPOSIT0 :$
725 %       WRITE
726 %       READ
727 %       CALLFSTR(#LV1,1,S)
728 %       IF #LV1.EQ.Y%HELP,GOTO 9001
729 %       EXIT
730 %9001  MAINFILE,GWAC132=DATA
731 %       [CHAINO,HELP]
732 %       [HELP]
733 %9999  CONTINUE
734 %END
735 ********
```

```
609 %       IF PGTST.NE.1,GOTO 6
610 %7      CALLFSTR(#GHXLN,1,2)
611 %       CALLCONV(#GHXLN,#GHXLN)
612 %       IF #GHXLN.LT.40,GOTO 6
613 %       GOTO 8
614 %       NOTE: INVALID RESPONSE
615 %6      OBEY 2100,9
616 %       NOTE: SET DEFAULT SIZE
617 %5      #GHXLN=60
④ 618 %     NOTE: OFFER FORMAT OPTION
619 %       #LLINE=6
620 %       #LSTOP=21
621 %       CALL 5000
622 %       NOTE: READ AND VALIDATE REPLY
623 %10     CALL 9000
624 %       SQUASH
625 %       IF #GSTC.GT.1,GOTO 13
626 %       CALLFSTR(#LV1,1,1)
627 %       IF #LV1.IN.' N',GOTO 11
628 %       IF #LV1.EQ.'Y',GOTO 12
629 %       NOTE: INVALID RESPONSE
630 %13     OBEY 2100,10
631 %       GOTO 10
632 %       NOTE: OPTION NOT YET AVAILABLE
633 %11     DEPOSIT0 THIS%OPTION%IS%NOT%YET%AVAILABLE.%PLEASE%DESIGN%YOUR%OWN$
634 %       CALLCOPY(57,%OUTPUT%FORMATS)
635 %       WRITE
⑤ 636 %     NOTE: PRINT DIALOGUE ABOUT DOMAIN LABELS
637 %12     #LLINE=22
638 %       #LSTOP=37
639 %       CALL 5000
⑥ 640 %     NOTE: INITIALISE DOMAININDEX POINTER AND CONTROL STRINGS
641         RESET #S03
642         RESET #S04
643         DEPOSIT3 AEFGHIJKLMOPQTUVWXYZ$
644 %       DEPOSIT4 #S03$
645 %       #LDIPT=1
⑦ 646 %     NOTE: DISPLAY NAMES IN DOMAININDEX AND BUILD UP LABEL TABLE
647 %14     SELECT DOMAININDEX
648 %       FREAD #LDIPT,#S01
649 %       NOTE: EXTRACT NAME AND TYPE
650 %       VSTR2 #S01,1,,
651 %       #GINP=#GCCT+1
652 %       CALLVSTR(#LV2,0,,)
653 %       #GINP=#GINP+#GCCT+1
654 %       CALLVSTR(#LV3,0,,)
655 %       #GINP=#GINP+#GCCT+1
656 %       CALLVSTR(#LV4,0,,)
657 %       NOTE: DISPLAY NAME AND READ LABEL CHARACTER ASSIGNED BY USER
658 %       DEPOSIT0 #S02$
659 %       WRITE
660 %15     CALL 9000
661 %       NOTE: VALIDATE LABEL
662 %       SQUASH
663 %       IF #GSTC.GT.1,GOTO 16
664 %       CALLFSTR(#LV1,1,1)
665 %       IF #LV1.EQ.' ',GOTO 18
666 %       IF #LV1.IN.#S04,GOTO 17
667 %       NOTE: INVALID RESPONSE
668 %16     OBEY 2100,15
669 %       NOTE: DELETE SELECTED CHARACTER FROM #S04
670 %       CALLSWAP(#S04,#LV1,#GSPCS)
671 %       SQUASH4
672 %       VSTR1 #S03,1,#LV1
673 %       #LLPT=#GCCT+1
⑧ 674 %     NOTE: SELECT LABEL TABLE AND WRITE RECORD
675 %       SELECT LABELTABLE
676 %       RESET #S01
```

```
EDITING FACILITIES WILL BE DESCRIBED TO YOU SHORTLY.
WHEN A DATA NAME IS DISPLAYED PLEASE TYPE THE CHARACTER YOU HAVE DECIDED
TO USE AS ITS LABEL. THE DEFAULT REPLY, MADE BY PRESSING THE ACCEPT KEY
ONLY, INDICATES THAT THE DATA DOES NOT APPEAR IN THE OUTPUT REPORT.
WHEN SPECIFYING THE FORMAT OF A LINE OF THE REPORT, THE PRINT POSITIONS
TO BE OCCUPIED BY AN ITEM ARE INDICATED BY TYPING THE LABEL CHARACTER
IN THE DESIRED POSITIONS OF THE LINE. BLANK CHARACTERS BEFORE AND
BETWEEN ITEMS SHOULD BE INDICATED BY TYPING THE # CHARACTER, BUT BLANK
CHARACTERS AT THE RIGHTHAND END OF A LINE MAY BE OMITTED.
E.G. IF S IS THE LABEL ASSIGNED TO PART-CODE DOMAIN ITEMS AND U IS THE
     LABEL ASSIGNED TO UNIT-COST DOMAIN ITEMS AND IT IS DESIRED TO PRINT
     THESE TWO ITEMS IN PRINT POSITIONS 10-16 AND 20-25 RESPECTIVELY,
     THEN THE REQUIRED FORMAT IS INDICATED BY THE FOLLOWING LINE;
##########SSSSSSS##UUUUUU
IF MORE PRINT POSITIONS ARE ALLOCATED TO AN ALPHANUMERIC ITEM THAN THE
ITEM ACTUALLY REQUIRES, THE ITEM IS LEFT JUSTIFIED IN THE SPECIFIED
POSITIONS AND PADDED OUT WITH BLANKS. IF TOO FEW PRINT POSITIONS ARE
ALLOCATED TO A DATA ITEM THEN CHARACTERS AT THE RIGHTHAND END WILL BE
TRUNCATED.
UNLESS THE EDITING FEATURE TO BE DESCRIBED SHORTLY IS IN USE, THE
DECIMAL POINT IN THE OUTPUT FORMAT OF A NUMERIC ITEM IS ASSUMED TO BE
AFTER THE RIGHTMOST DIGIT. LEADING ZEROS ARE REPLACED BY BLANKS UP TO
BUT NOT INCLUDING A ZERO BEFORE THE IMPLIED DECIMAL POINT. THE DECIMAL
POINT LOCATION IN THE ITEM TO BE OUTPUT IS ALIGNED WITH THAT IMPLIED IN
THE OUTPUT FORMAT. IF MORE PRINT POSITIONS ARE ALLOCATED THAN THE ITEM
REQUIRES, THE UNUSED POSITIONS BEFORE THE DECIMAL POINT WILL BE FILLED
WITH BLANKS. IF TOO FEW PRINT POSITIONS ARE ALLOCATED THEN THE HIGH
ORDER DIGITS ARE TRUNCATED TO MAKE IT FIT.
********
INPUT
STAGE8
%DEF STAGE8
%     NOTE: REPORT LAYOUT INTRODUCTION - CHECK POINT 8
(1)   %     #GCKPT=8
%     NOTE: PRINT INTRODUCTORY DIALOGUE
(2)   %     #LLINE=1
%     #LSTOP=5
%     CALL 5000
%     NOTE: READ AND VALIDATE PAGE WIDTH OPTION
%1    CALL 9000
%     SQUASH
%     IF #GSTC.GT.1,GOTO 2
%     CALLFSTR(#GWDTH,1,1)
%     IF #GWDTH.IN.' N',GOTO 4
%     IF #GWDTH.EQ.'U',GOTO 3
%     NOTE: INVALID RESPONSE
%2    OBEY 2100,1
%     NOTE: WIDE PAGE FACILITIES NOT YET IMPLEMENTED
%3    DEPOSIT0 WIDE%PAGE%FACILITIES%NOT%YET%IMPLEMENTED.%NARROW%ASSUMED$
%      WRITE
%     #GWIDTH='N'
(3)   %     NOTE: REQUEST NO. OF LINES
%4    DEPOSIT0 PLEASE%TYPE%THE%MAXIMUM%NUMBER%OF%LINES%TO%BE%PRINTED%ON$
      CALLCOPY(57,%A%REPORT%PAGE)
%     WRITE
%     DEPOSIT0 THIS%MUST%BE%A%VALUE%IN%THE%RANGE%40%TO%99.%THE%DEFAULT%3$
%     CALLCOPY(57,VALUE%IS%60)
%     WRITE
%     NOTE: READ AND VALIDATE RESPONSE
%9    CALL 9000
%     SQUASH
%     IF #GSTC.LT.1,GOTO 5
%     IF #GSTC.GT.2,GOTO 6
%     CALLFSTR(#LV1,1,1)
%     TESTDIGT(#LV1)
%     IF #GTST.NE.1,GOTO 6
%     CALLFSTR(#LV1,2,1)
%     TESTDIGT(#LV1)
%     #0000 #FIND=0
```

SEPARATE FOLDER OF LISTINGS

CONTENTS

SEPARATE FOLDER OF LISTINGS

Notes:

1. The type face of the teletype on which items 1 to 21 and 28 were produced causes £ to appear as ∅ and ∅ to appears as \.

2. The parameter marker used during the Filetab to COBOL generation study was / (Items 1 to 10). The parameter marker used during the development of macros for the COBOL report program generating system was @ (Items 11 to 28).

3. The development of items 20 to 28 is incomplete.

1. OUTLINE PROCESSING FOR THE COBOLGEN MACRO

```
%MACRO%/.
%BEGIN
%DEF   COBOLGEN(//)
%      NOTE: INITIALISATION
       :
       :
       :
       :
%      NOTE: READ FIRST RECORD
%1     READ
%      NOTE: IDENTIFY RECORD TYPE. ONLY THE
%      NOTE: FOLLOWING ARE VALID -
%      NOTE: * , *FILE, *INL, *TITLE, *HEAD, *OUT, *GO
%      NOTE: #LV1 IS USED TO CONTAIN FIRST 8 CHARACTERS
%      NOTE: OF INPUT BUFFER
%      NOTE: LITERALS ARE THEN MATCHED AGAINST #LV1
%10    CALLFSTR(#LV1,1,8)
%      IF '* '.AT.#LV1,GOTO 2
%      IF '*FILE'.AT.#LV1,GOTO 3
%      IF '*INL'.AT.#LV1,GOTO 4
%      IF '*TITLE'.AT.#LV1,GOTO 5
%      IF '*HEAD'.AT.#LV1,GOTO 6
%      IF '*OUT'.AT.#LV1,GOTO 7
%      IF '*GO'.AT.#LV1,GOTO 8
%      NOTE: ERROR CONDITION - WRITE MESSAGE AND TERMINATE RUN
%      CALLCOPY(1,COBOLGEN%ERROR%CONDI)
%      CALLCOPY(21,TION%)
%      CALLCOPY(27,#LV1)
%      WRITE
%      GOTO 9999
       :
       :
       :
       :
       :
       :
%9999  CONTINUE
%END
```

2. INITIALISATION SECTION OF COBOLGEN MACRO

```
%       NOTE: INITIALISATION
%       NOTE: GENERATE VARIABLE CONTAINING QUOTE
%       READ
%       CALLFSTR(#GQUO,1,1)
%       NOTE: GENERATE VARIABLE CONTAINING #
%       #GHATC='#'
%       NOTE: #GV2 = DEFAULT VALUE FOR PROGRAM ID
%       #GV2='TABC'
%       NOTE: INITIALISE MACROS ABOUT TO BE GENERATED
%       #GS01=0
%       #GFIL='NOTEPARA'
%       OBEY 101,11
%11     #GFIL='TITLES'
%       OBEY 101,12
%12     #GS03=0
%       #GFIL='TITLEPAR'
%       OBEY 101,13
%13     #GFIL='OTHERPAR'
%       OBEY 101,14
%14     #GFIL='HEADINGS'
%       OBEY 101,15
%15     #GFIL='INPUTREC'
%       OBEY 101,16
%16     #GFIL='CTRLBRKE'
%       OBEY 101,17
%17     #GFIL='SAVETOTL'
%       OBEY 101,18
%18     #GFIL='ADDPARA'
%       #GS15=0
%       OBEY 101,26
%26     #GFIL='WRITEPAR'
%       OBEY 101,19
%19     #GFIL='MOVEPARA'
%       OBEY 101,20
%20     #GFIL='OUTREC'
%       OBEY 101,21
%21     #GFIL='BREAKPAR'
%       OBEY 101,24
%24     #GFIL='PAGEPARA'
%       OBEY 101,22
%22     #GFIL='FINALPAR'
%       #GS12=0
%1      OBEY 101,1
```

3. SKELETON COBOL PROGRAM - GOPART2 SUBFILE

```
%MACRO%/.
%BEGIN
%FILE,Ø,GOPART2\
%DEF   GOPART2
%      #LV1='Ø1'
       [PART1]
       ****
              IDENTIFICATION DIVISION.
              PROGRAM-ID. #GV2#LV1.
              ENVIRONMENT DIVISION.
              SOURCE-COMPUTER. ICL-19Ø7.
              OBJECT-COMPUTER. ICL-19Ø7 MEMORY SIZE 19ØØØ WORDS.
              INPUT-OUTPUT SECTION.
              FILE-CONTROL.
                  SELECT #SØ6 ASSIGN TO #GV11#GV12 1.
                  SELECT LINE-PRINTER ASSIGN TO PRINTER 1.
              DATA DIVISION.
              FILE SECTION.
              FD #SØ6
                  BLOCK CONTAINS 2Ø48 CHARACTERS
                  LABEL RECORDS #SØ7
                  DATA RECORD IS INREC.
              Ø1  INREC.
                  Ø2  IN-REC.
                  Ø3  FILLER PICTURE X(12Ø) OCCURS 17.
                  Ø3 FILLER PICTURE X(8).
       [INPUTREC]
              FD  LINE-PRINTER
                  LABEL RECORDS OMITTED
                  DATA RECORD IS OUTREC.
              Ø1  OUTREC PICTURE X(12Ø).
              WORKING-STORAGE SECTION.
              77  LINE-COUNT PICTURE 99 VALUE ZERO.
              77  PAGE-SWITCH PICTURE 9 VALUE ZERO.
              Ø1  CONTROL-BREAK.
                  Ø2  FILLER PICTURE X.
       [CTRLBRKE]
              Ø1  CONTROL-TOTALS.
                  Ø2  FILLER PICTURE X.
%      RESET #SØ1
%      DEPOSIT1 #GOUT\
%      READ #SØ1
```

```
%       #GINP=1
%902    CALLFSTR(#LV1,0,1)
%       IF #LV1.EQ.'L',GOTO 901
                    02  #LV1-LEVEL.
               [SAVETOTL]
%901    #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 902
        [TITLES]
        [HEADINGS]
        [OUTREC]
               PROCEDURE DIVISION.
%       IF #GS01.EQ.0,GOTO 912
        [NOTEPARA]
%912    CONTINUE
               PARA-1.
                    OPEN INPUT #S06
                    OUTPUT LINE-PRINTER.
                    MOVE SPACES TO OUTREC.
                    WRITE OUTREC BEFORE ADVANCING CHANNEL-1.
               PARA-READ.
                    READ #S06 AT END GO TO PARA-3.
               PARA-4.
%       RESET #S01
%       DEPOSIT1 #GOUT\
%       READ #S01
%       SQUASH
%       #GINP=1
%903    CALLFSTR(#LV1,0,1)
%       IF #LV1.EQ.'L',GOTO 904
%       IF #LV1.EQ.'F',GOTO 904
                    MOVE #LV1 IN INREC TO #LV1 IN CONTROL-BREAK.
%904    #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 903
%       IF #GS15.EQ.0,GOTO 905
                    PERFORM PARA-ADD.
%905    IF #GS03.EQ.0,GOTO 906
                    PERFORM PARA-TITLE.
%906    CONTINUE
                    PERFORM PARA-PAGE.
               PARA-2.
                    PERFORM PARA-MOVE.
                    PERFORM PARA-WRITE.
                    PERFORM PARA-READ.
                    PERFORM PARA-BREAK THRU PARA-BREAK-EXIT.
```

```
                    PERFORM PARA-ADD.
%914   CONTINUE
                    GO TO PARA-2.
               PARA-3.
                    PERFORM PARA-BREAK THRU PARA-BREAK-EXIT.
%      IF #GS12.EQ.0,GOTO 913
                    PERFORM PARA-FINAL.
%913   CONTINUE
                    CLOSE #S06
                    LINE-PRINTER.
                    STOP RUN.
%      IF #GS15.EQ.0,GOTO 907
               PARA-ADD.
       [ADDPARA]
%907   IF #GS03.EQ.0,GOTO 908
               PARA-TITLE.
       [TITLEPAR]
%908   CONTINUE
               PARA-PAGE.
       [PAGEPARA]
               PARA-MOVE.
       [MOVEPARA]
               PARA-WRITE.
       [WRITEPAR]
       [BREAKPAR]
%      IF #GS12.EQ.0,GOTO 909
               PARA-FINAL.
       [FINALPAR]
%909   IF 'L'.IN.#GHED,GOTO 910
               PARA-LINE-CHECK. EXIT.
%      GOTO 911
%910   CONTINUE
               PARA-LINE-CHECK. IF LINE-COUNT GREATER THAN #GVZ PERFORM
                    PARA-PAGE, MOVE 1 TO PAGE-SWITCH, GO TO PARA-LINE-EXIT.

                    MOVE 0 TO PAGE-SWITCH.
%911   CONTINUE
               PARA-LINE-EXIT. EXIT.
       [OTHERPAR]
       ****
%999   CONTINUE
%END
%%%%%%%%
```

4. * COMMENT PROCESSING

```
%       NOTE: PROCESS * COMMENT RECORDS
%       NOTE: PREPARE TO WRITE ON NOTEPARA SUBFILE
%2      #GFIL='NOTEPARA'
%       OBEY 102,201
%       NOTE: TEST FOR FIRST COMMENT
%201    IF #GS01.NE.0,GOTO 202
%       NOTE: WRITE PARAGRAPH STATEMENT ON NOTEPARA SUBFILE
                NOTE-PARA. NOTE
%       NOTE: SET #GS01 TO BE NON-ZERO
%       #GS01=1
%       NOTE: SAVE COMMENT CHARACTERS 3-6 IN #GV2 AS PROGRAM ID
%       CALLFSTR(#GV2,3,4)
%       NOTE: EXTRACT FIRST 60 CHARACTERS
%202    CALLFSTR(#LV1,1,8)
%       CALLFSTR(#LV2,9,8)
%       CALLFSTR(#LV3,17,8)
%       CALLFSTR(#LV4,25,8)
%       CALLFSTR(#LV5,33,8)
%       CALLFSTR(#LV6,41,8)
%       CALLFSTR(#LV7,49,8)
%       CALLFSTR(#LV8,57,4)
%       NOTE: OUTPUT COMMENT TO NOTEPARA SUBFILE
                #LV1#LV2#LV3#LV4#LV5#LV6#LV7#LV8
%       NOTE: EXTRACT CHARACTERS 61-72
%       CALLFSTR(#LV1,61,8)
%       CALLFSTR(#LV2,69,4)
                #LV1#LV2
        /1//1//1//1//1//1//1//1/
%       GOTO 1
```

```
%       NOTE: ROUTINE FOR PROCESSING *FILE DIRECTIVES
%       NOTE: #S06 USED FOR FILE NAME
%       NOTE: #S07=LABEL OPTION
%       NOTE: RESET #S01 FOR USE AS TEMPORARY STORE
%3      RESET #S06
%       RESET #S01
%       NOTE: START GENERATING CONSTANTS MACRO
        /1/FILE,0,CONSTANTS\
        /1/DEF  CONSTANTS
        /1/     RESET #GHATCS06
        /1/     RESET #GHATCS07
%       NOTE: TEST PERIPHERAL OPTION FOR CARDS OR TAPE
%       CALLFSTR(#LV1,7,2)
%       IF #LV1.EQ.'CR',GOTO 301
%       IF #LV1.EQ.'MT',GOTO 302
%       NOTE: ERROR CONDITION ENCOUNTERED. WRITE ERROR MESSAGE
%       CALLCOPY(1,TABNFILE%ERROR)
%       WRITE
%       GOTO 306
%       NOTE: #GV11 AND #GV12 USED FOR INPUT MEDIUM SPECIFICATION
%301    #GV11='CARD-REA'
%       #GV12='DER'
%       NOTE: TEST POSITION 10 FOR PRESENCE OF FILENAME
%       CALLFSTR(#LV1,10,1)
%       IF #LV1.EQ.' ',GOTO 303
%       GOTO 304
%       NOTE: SET #S06 = DEFAULT FILE NAME
%       NOTE: SET #S07 = LABEL OPTION
%303    DEPOSIT6 DEFAULT-NAME\
        /1/     DEPOSIT7 OMITTED\
%       GOTO 306
%302    #GV11='TAPE'
%       #GV12='S'
%       NOTE: EXTRACT AND STORE FILE NAME
%304    #GINP=10
%307    CALLFSTR(#LV1,0,1)
%       IF #LV1.EQ.',',GOTO 308
%       DEPOSIT1 #LV1\
%       DEPOSIT6 #LV1\
%       #GINP=#GINP+1
%       IF #GINP.LT.22,GOTO 307
%308    IF #GINP.EQ.11,GOTO 309
%       READ #S01
%       SQUASH
%       IF #GSTC.EQ.0,GOTO 309
        /1/     DEPOSIT7 STANDARD/1/VALUE/1/OF/1/ID/1/"#S06"\
%       GOTO 306
%309    CONTINUE
        /1/     DEPOSIT7 STANDARD/1/VALUE/1/OF/1/ID/1/\
        /1/     DEPOSIT7 "/1//1//1//1//1//1//1/"\
%       RESET #S06
%       DEPOSIT6 DEFAULT-NAME\
%306    CONTINUE
        /1/     DEPOSIT6 #S06\
        /1//1//1//1//1//1//1/
%       GOTO 1
```

6. *INL PROCESSING

```
%       NOTE: ROUTINE FOR PROCESSING *INL DIRECTIVES
%       NOTE: AND PARAMETERS
%       NOTE: SET FIELD COUNT TO Ø
%4      #GFCT=Ø
%4Ø1    READ
%       NOTE: READ RECORD AND SET #GINP=Ø
%       #GINP=Ø
%       NOTE: TEST FOR * RECORD
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 1Ø
%       NOTE: SQUASH INPUT BUFFER AND SAVE LENGTH IN #LSTC
%       SQUASH
%       #LSTC=#GSTC
%       NOTE: LOCATE AND STORE FIELD SPECIFIER IN #GV4
%411    #GINP=#GINP+1
%       CALLFSTR(#GV4,Ø,1)
%       NOTE: ADD 1 TO FIELD COUNT
%       #GFCT=#GFCT+1
%       NOTE: RESET #SØ1 AND STORE STRING OF NUMERIC START POSITION
%       NOTE: CHARACTERS IN IT
%       RESET #SØ1
%       NOTE: INCREASE #GINP, LOOK AT NEXT CHARACTER AND TEST FOR NUMERIC

%4Ø2    #GINP=#GINP+1
%       CALLFSTR(#LV1,Ø,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.Ø,GOTO 4Ø3
%       DEPOSIT1 #LV1\
%       GOTO 4Ø2
%       NOTE: TRANSFER CONTENTS OF #SØ1 TO #GV5 USING #SØ9 AS
%       NOTE: INTERMEDIATE STORAGE. SAVE #GINP IN #LINP
%4Ø3    RESET #SØ9
%       WRITE #SØ9
%       #LINP=#GINP
%       READ #SØ1
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV5,1,Ø)
%       READ #SØ9
%       SQUASH
```

```
%       #GINP=#LINP
%       NOTE: STORE TYPE CHARACTER IN #GV6
%       #GV6=#LV1
%       NOTE: RESET #S01 AND STORE LENGTH OR END SPECIFIER IN IT
%       RESET #S01
%       NOTE: INCREASE #GINP, LOOK AT NEXT CHARACTER AND TEST FOR NUMERIC

%405    #GINP=#GINP+1
%       CALLFSTR(#LV1,0,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.0,GOTO 444
%       DEPOSIT1 #LV1\
%       NOTE: CHECK FOR END OF BUFFER
%       IF #GINP.GE.#LSTC,GOTO 444
%       GOTO 405
%       NOTE: TRANSFER CONTENTS OF #S01 TO #GV7 USING #S09, SAVE #GINP IN

%       NOTE: #LINP
%444    RESET #S09
%       WRITE #S09
%       #LINP=#GINP
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV7,1,0)
%       READ #S09
%       SQUASH
%       #GINP=#LINP
%       NOTE: CONVERT START POSITION FROM CHARACTERS TO BINARY
%       CALLCONV(#GV5,#GV5)
%       NOTE: CONVERT LENGTH OR END FROM CHARACTERS TO BINARY
%       CALLCONV((#GV7,#GV7)
%       NOTE: IDENTIFY TYPE
%       IF #GV6.NE.'-',GOTO 446
%       NOTE: COMPUTE LENGTH AND STORE IN #GV7
%       #GV7=#GV7-#GV5+1
%       #GV5=#GV5-1
%406    CONTINUE
%       NOTE: GENERATE 02 LEVEL STATEMENT
%       #GFIL='INPUTREC'
%       OBEY 102,421
%421    IF #GFCT.NE.1,GOTO 422
                    02 FILLER-1 REDEFINES IN-REC.
%       GOTO 423
%422    #LV1=#GFCT-1
                    02 FILLER-#GFCT REDEFINES FILLER-#LV1.
```

```
%423   IF #GV5.EQ.0,GOTO 409
%      NOTE: GENERATE INITIAL FILLER STATEMENT(S)
%      #LV1=407
%      GOTO 433
%409   CONTINUE
       /1///1///1///1///1///1///1/
%      NOTE: TEST FIELD SPECIFIER FOR TOTALLING FIELD
%407   TESTDIGT(#GV4)
%      IF #GTST.NE.0,GOTO 408
%      NOTE: WRITE CONTROL ITEM ON SAVETOTL SUBFILE
%      #GFIL='SAVETOTL'
%      OBEY 102,425
%425   CONTINUE
                  03 A#GV4 PICTURE 9(15) COMPUTATIONAL VALUE ZERO.
       /1///1///1///1///1///1///1/
%      NOTE: WRITE 03 LEVEL STATEMENT ON INPUTREC SUBFILE
%      #GFIL='INPUTREC'
%      OBEY 102,426
%426   CONTINUE
                  03 A#GV4 PICTURE 9(#GV7).
       /1///1///1///1///1///1///1/
%      NOTE: WRITE ADD PARAGRAPH STATEMENTS
%      #GFIL='ADDPARA'
%      #GS15=1
%      OBEY 102,440
%440   CONTINUE
                  ADD A#GV4 IN INREC TO A#GV4 IN 1-LEVEL.
       /1///1///1///1///1///1///1/
%      GOTO 414
%      NOTE: TEST FOR CONTROL BREAK ITEM
%408   IF #GV4.IN.'1NOPGR',GOTO 410
%      GOTO 413
%      NOTE: WRITE CONTROL BREAK ITEM ON CTRLBRKE SUBFILE
%410   #GFIL='CTRLBRKE'
%      OBEY 102,427
%427   CONTINUE
                  02 #GV4 PICTURE X(#GV7).
       /1///1///1///1///1///1///1/
%      NOTE: WRITE 03 LEVEL STATEMENT ON INPUTREC SUBFILE
%      #GFIL='INPUTREC'
%      OBEY 102,428
%428   CONTINUE
                  03 #GV4 PICTURE X(#GV7).
       /1///1///1///1///1///1///1/
```

```
%       NOTE: GENERATE FINAL FILLER STATEMENT
%414    #LV1=2048-#GV5-#GV7
%       IF #LV1.EQ.0,GOTO 415
%       #GFIL='INPUTREC'
%       OBEY 102,429
%429    #LV3=415
%       NOTE: GENERATE FILLER STATEMENT(S)
%433    #LV2=0
%424    IF #LV1.LT.120,GOTO 431
%       #LV1=#LV1-120
%       #LV2=#LV2+1
%       GOTO 424
%431    IF #LV1.EQ.0,GOTO 452
                    03 FILLER PICTURE X(#LV1).
%452    IF #LV2.EQ.0,GOTO 430
%       IF #LV2.EQ.1,GOTO 450
                    03 FILLER PICTURE X(124) OCCURS #LV2.
%       GOTO 430
%450    CONTINUE
                    03 FILLER PICTURE X(124).
%430    CONTINUE
        /1///1///1///1///1///1///1/
%       GOTO #LV3
%       NOTE: TEST FOR END OF INPUT BUFFER
%415    IF #GINP.GE.#LSTC,GOTO 401
%       GOTO 411
```

7. *TITLE PROCESSING

```
%       NOTE: ROUTINE FOR PROCESSING *TITLE DIRECTIVES AND PARAMETERS
%       NOTE: SET TITLEPAR SWITCH #GSØ3 =1
%5      #GSØ3=1
%       NOTE: SQUASH INPUT BUFFER AND EXTRACT SKIP BEFORE AND SKIP AFTER
%       NOTE: COUNTS AFTER SETTING DEFAULT VALUES USING #GV4 AND #GV5
%       #GV4='1'
%       #GV5='3'
%       SQUASH
%       IF #GSTC.EQ.6,GOTO 5Ø1
%       CALLVSTR(#GV4,7,,)
%       #GINP=#GCCT+7
%       IF #GSTC.LE.#GINP,GOTO 5Ø1
%       #GINP=#GINP+1
%       CALLVSTR(#GV5,Ø,,)
%       NOTE: SET TITLE LINE COUNTER #GV6=1
%5Ø1    #GV6=1
%       NOTE: REMOVE UNWANTED SPACES FROM #GV4 AND #GV5 USING #SØ9
%       RESET #SØ9
%       DEPOSIT9 #GV4\
%       READ #SØ9
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV4,1,Ø)
%       RESET #SØ9
%       DEPOSIT9 #GV5\
%       READ #SØ9
%       SQUASH
%       #GOUP=#GSTC
%       NOTE: READ PARAMETER RECORD AND TEST FOR * RECORD USING #LV1
%5Ø2    READ
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 5Ø3
%       NOTE: GENERATE Ø1 LEVEL ENTRY
%5Ø6    #GFIL='TITLES'
%       OBEY 1Ø2,51Ø
%51Ø    CONTINUE
```

```
                01  TITLE-#GV6.
%       NOTE: EXTRACT FIRST 58 CHARACTERS FROM INPUT BUFFER
%       CALLFSTR(#LV1,1,8)
%       CALLFSTR(#LV2,9,8)
%       CALLFSTR(#LV3,17,8)
%       CALLFSTR(#LV4,25,8)
%       CALLFSTR(#LV5,33,8)
%       CALLFSTR(#LV6,41,8)
%       CALLFSTR(#LV7,49,8)
%       CALLFSTR(#LV8,57,2)
%       NOTE: GENERATE 02 LEVEL ENTRY
                    02 FILLER PICTURE X(58) VALUE
                    "#LV1#LV2#LV3#LV4#LV5#LV6#LV7#LV8".
%       NOTE: EXTRACT CHARACTERS 59-72
%       NOTE: FROM INPUT BUFFER
%       CALLFSTR(#LV1,59,8)
%       CALLFSTR(#LV2,67,6)
%       NOTE: GENERATE 02 LEVEL ENTRY
                    02 FILLER PICTURE X(14) VALUE "#LV1#LV2".
%       NOTE: READ RECORD AND TEST FOR * IN POSITION 1
%       READ
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 544
%       CALLFSTR(#LV1,1,8)
%       CALLFSTR(#LV2,9,8)
%       CALLFSTR(#LV3,17,8)
%       CALLFSTR(#LV4,25,8)
%       CALLFSTR(#LV5,33,8)
%       CALLFSTR(#LV6,41,8)
%       NOTE: GENERATE 02 LEVEL ENTRY
                    02 FILLER PICTURE X(48) VALUE
                    "#LV1#LV2#LV3#LV4#LV5#LV6".
%       NOTE: READ RECORD AND EXTRACT 1ST CHARACTER IN #LV1
%       READ
%       CALLFSTR(#LV1,1,1)
%       NOTE: END OF LEVEL ENTRY GENERATION
%545    CONTINUE
        /1///1//1//1//1//1//1/
%       #GFIL='TITLEPAR'
%       OBEY 102,512
%       NOTE: TEST FOR FIRST LINE
%512    IF #GV6.EQ.1,GOTO 507
%       NOTE: GENERATE WRITE STATEMENT FOR TITLE LINE NOT THE FIRST
                    WRITE OUTREC FROM TITLE-#GV6 AFTER ADVANCING 1.
                    ADD 1 TO LINE-COUNT.
```

```
%508   IF #LV1.EQ.'*',GOTO 503
%      NOTE: NOT A * RECORD - FINISH TITLEPAR GENERATION
       /1///1///1///1///1///1///1/
%      #GV6=#GV6+1
%      GOTO 506
%      NOTE: GENERATE FILLER OF SPACES TO MAKE UP 120 CHARACTER LINE
%504   CONTINUE
                    02 FILLER PICTURE X(48) VALUE SPACES.
%      GOTO 505
%      NOTE: GENERATE WRITE STATEMENT FOR FIRST TITLE LINE
%507   CONTINUE
                    WRITE OUTREC FROM TITLE-1 AFTER ADVANCING #GV4.
                    ADD #GV4 TO LINE-COUNT.
%      GOTO 508
%      NOTE: GENERATE STATEMENTS FOR SPACING AFTER TITLE
%503   IF #GV5.EQ.'0',GOTO 509
                    MOVE SPACES TO OUTREC.
                    WRITE OUTREC AFTER ADVANCING #GV5.
                    ADD #GV5 TO LINE-COUNT.
%509   CONTINUE
       /1///1///1///1///1///1///1/
%      GOTO 10
```

8. *HEAD PROCESSING

```
%       NOTE: ROUTINE FOR PROCESSING *HEAD DIRECTIVE AND PARAMETER RECORDS

%       NOTE: INITIALISE #GHED TO SPACES
%6      #GHED=#GSPC
%       NOTE: SET DEFAULT VALUES FOR VARIABLES
%       NOTE: #GV4 = CONTROL LEVEL
%       NOTE: #GV5 = SKIP BEFORE COUNT
%       NOTE: #GV6 = SKIP AFTER COUNT
%       NOTE: #GVZ = PAGE LIMIT
%601    #GV4='L'
%       #GV5='1'
%       #GV6='1'
%       #GVZ='60'
%       NOTE: SQUASH INPUT BUFFER
%       SQUASH
%       NOTE: TEST FOR END OF BUFFER
%       IF #GSTC.EQ.5,GOTO 602
%       NOTE: COPY CONTROL LEVEL INTO #GV4
%       CALLFSTR(#GV4,6,1)
%       NOTE: TEST FOR END OF BUFFER
%       IF #GSTC.EQ.6,GOTO 602
%       NOTE: COPY SKIP BEFORE COUNT INTO #GV5
%       CALLVSTR(#GV5,7,,)
%       NOTE: TEST FOR END OF BUFFER
%       #GINP=#GCCT+7
%       IF #GINP.GE.#GSTC,GOTO 602
%       NOTE: COPY SKIP AFTER COUNT INTO #GV6
%       #GINP=#GINP+1
%       CALLVSTR(#GV6,0,,)
%       NOTE: IF LEVEL 'L' TEST FOR NO. OF LINES PARAMETER
%       IF #GV4.NE.'L',GOTO 602
%       #GINP=#GINP+#GCCT
%       IF #GINP.GE.#GSTC,GOTO 602
%       NOTE: COPY NO. OF LINES PER PAGE INTO #GVZ
%       #GINP=#GINP+1
%       CALLVSTR(#GVZ,0,,)
%       NOTE: SET HEADING LINE COUNT #GHCT = 1
%602    #GHCT=1
%       NOTE: SAVE HEADING LEVEL #GV4 IN #GHED USING #S09
%       RESET #S09
%       DEPOSIT9 #GV4#GHED\
%       READ #S09
%       CALLFSTR(#GHED,1,8)
```

```
%       NOTE: REMOVE UNWANTED SPACES FROM #GV5 #GV6 AND #GV7 USING #S09
%       RESET #S09
%       DEPOSIT9 #GV5
%       READ #S09
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV5,1,0)
%       RESET #S09
%       DEPOSIT9 #GV6\
%       READ #S09
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV6,1,0)
%       RESET #S09
%       DEPOSIT9 #GVZ\
%       READ #S09
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GVZ,1,0)
%       NOTE: GENERATE PARAGRAPH HEADING AND LEVEL 01 ENTRY
%       #GFIL='OTHERPAR'
%       OBEY 102,609
%609    CONTINUE
                #GV4-HEAD-WRITE.
        /1///1///1///1///1///1///1/
%       NOTE: READ RECORD
%       READ
%603    #GFIL='HEADINGS'
%       OBEY  102,611
%611    CONTINUE
                01 #GV4-HEAD-#GHCT.
%       NOTE: EXTRACT FIRST 58 CHARACTERS
%       CALLFSTR(#LV1,1,8)
%       CALLFSTR(#LV2,9,8)
%       CALLFSTR(#LV3,17,8)
%       CALLFSTR(#LV4,25,8)
%       CALLFSTR(#LV5,33,8)
%       CALLFSTR(#LV6,41,8)
%       CALLFSTR(#LV7,49,8)
%       CALLFSTR(#LV8,57,2)
                    02 FILLER PICTURE X(58) VALUE
                    "#LV1#LV2#LV3#LV4#LV5#LV6#LV7#LV8".
%       NOTE: EXTRACT CHARACTERS 59 - 72
%       CALLFSTR(#LV1,59,8)
%       CALLFSTR(#LV2,67,6)
                    02 FILLER PICTURE X(14) VALUE "#LV1#LV2".
```

```
%       NOTE: READ RECORD AND TEST FOR * RECORD
%       READ
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 604
%       NOTE: EXTRACT CHARACTERS 1 TO 48
%       CALLFSTR(#LV1,1,8)
%       CALLFSTR(#LV2,9,8)
%       CALLFSTR(#LV3,17,8)
%       CALLFSTR(#LV4,25,8)
%       CALLFSTR(#LV5,33,8)
%       CALLFSTR(#LV6,41,8)
                    02 FILLER PICTURE X(48) VALUE
                    "#LV1#LV2#LV3#LV4#LV5#LV6".
%       NOTE: READ NEXT RECORD AND TEST FOR *
%       READ
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 605
        /1///1///1///1///1///1///1/
%       NOTE: GENERATE WRITE VERB STATEMENTS
%       #LII=624
%       GOTO 621
%624    #GHCT=#GHCT+1
%       GOTO 603
%       NOTE: GENERATE SPACE FILLER FOR MISSING SECOND RECORD
%604    CONTINUE
                    02 FILLER PICTURE X(48) VALUE SPACES.
%605    CONTINUE
%       #LII3=620
%       GOTO 621
%       NOTE: TEST SPACING AFTER OPTION
%620    IF #GV6.EQ.'0',GOTO 608
%       NOTE: GENERATE SPACING AFTER STATEMENTS
%       #GFIL='OTHERPAR'
%       OBEY 102,616
%616    CONTINUE
                    MOVE SPACES TO OUTREC.
                    WRITE OUTREC AFTER ADVANCING #GV6.
                    ADD #GV6 TO LINE-COUNT.
        /1///1///1///1///1///1///1/
%       NOTE: TEST FOR *HEAD RECORD
%608    CALLFSTR(#LV1,1,8)
%       IF '*HEAD'.AT.#LV1,GOTO 601
%       GOTO 10
%621    #GFIL='OTHERPAR'
%       OBEY 102,618
```

```
%       NOTE: TEST FOR FIRST LINE OF HEADING
%618    IF #GHCT.EQ.1,GOTO 619
                    WRITE OUTREC FROM #GV4-HEAD-#GHCT AFTER ADVANCING 1.
                    ADD 1 TO LINE-COUNT.
%       GOTO 622
%619    CONTINUE
                    WRITE OUTREC FROM #GV4-HEAD-#GHCT AFTER ADVANCING #GV5.

                    ADD #GV5 TO LINE-COUNT.
%622    CONTINUE
        /1///1///1///1///1///1///1/
%       GOTO #LU3
```

9. *OUT PROCESSING

```
%       NOTE: ROUTINE FOR PROCESSING *OUT DIRECTIVES AND PARAMETERS
%       NOTE: INITIALISE #GOUT TO SPACES
%7      #GOUT=#GSPC
%       NOTE: SET DEFAULT VALUES FOR VARIABLES
%       NOTE: #GV4=CONTROL LEVEL
%       NOTE: #GV5=SKIP BEFORE COUNT
%       NOTE: #GV6=SKIP AFTER COUNT
%701    #GV4='L'
%       #GV5='1'
%       #GV6='1'
%       NOTE: SQUASH INPUT BUFFER
%       SQUASH
%       NOTE: TEST FOR END OF BUFFER
%       IF #GSTC.EQ.4,GOTO 702
%       NOTE: COPY CONTROL LEVEL INTO #GV4
%       CALLFSTR(#GV4,5,1)
%       NOTE: TEST FOR END OF BUFFER
%       IF #GSTC.EQ.5,GOTO 702
%       NOTE: COPY SKIP BEFORE COUNT INTO #GV5
%       CALLVSTR(#GV5,6,,)
%       NOTE: TEST FOR END OF BUFFER
%       #GINP=#GCCT+6
%       IF #GINP.GE.#GSTC,GOTO 702
%       NOTE: COPY SKIP AFTER COUNT INTO #GV6
%       #GINP=#GINP+1
%       CALLVSTR(#GV6,0,,)
%       NOTE: SAVE OUTPUT LEVEL #GV4 IN #GOUT USING #S01
%       RESET #S01
%       DEPOSIT1 #GV4#GOUT\
%       READ #S01
%       CALLFSTR(#GOUT,1,8)
%       NOTE: SET OUTPUT LINE #GOCT = 0
%702    #GOCT=0
%       NOTE: SET PARAGRAPH SWITCH #GPSW=0
%       #GPSW=0
%       NOTE: REMOVE UNWANTED SPACES FROM #GV5 AND #GV6 USING #S01
%       RESET #S01
%       DEPOSIT1 #GV5\
%       READ #S01
```

```
%       #GOUP=#GSTC
%       CALLFSTR(#GV5,1,Ø)
%       RESET #SØ1
%       DEPOSIT1 #GV6\
%       READ #SØ1
%       SQUASH
%       #GOUP=#GSTC
%       CALLFSTR(#GV6,1,Ø)
%       NOTE: READ RECORD AND SET #GINP = 1
%       READ
%       #GINP=1
%       NOTE: INCREMENT LINE COUNT AND SET INDICATOR #LV2 TO Ø
%767    #GOCT=#GOCT+1
%       #LV2=Ø
%       NOTE: SET MOVE SWITCH #GMVE = Ø
%       #GMVE=Ø
%       #GFIL='OUTREC'
%       OBEY 102,71Ø
%71Ø    CONTINUE
%       NOTE: GENERATE LEVEL Ø1 ENTRY
                Ø1  #GV4-REC#GOCT.
        /1///1///1///1///1///1///1/
%       NOTE: EXTRACT NEXT CHARACTER FROM INPUT BUFFER IN #LV1
%       #LU3=7Ø3
%       GOTO 76Ø
%       NOTE: TEST #LV1 FOR BLANK
%7Ø3    IF #LV1.EQ.' ',GOTO 7Ø4
%       NOTE: TEST FOR START OF LITERAL
%       IF #LV1.EQ.#GQUO,GOTO 7Ø5
%       NOTE: SAVE CHARACTER IN #GV9 AND START CHARACTER COUNT #GV7
%       #GV9=#LV1
%       #GV7=1
%       NOTE: EXTRACT NEXT CHARACTER
%7Ø6    #LU3=7Ø7
%       GOTO 76Ø
%       NOTE: TEST FOR END OF LINE
%7Ø7    IF #LV2.GT.1,GOTO 7Ø8
%       NOTE: TEST FOR SAME CHARACTER AS PREVIOUS
%       IF #GV9.NE.#LV1,GOTO 7Ø8
%       NOTE: INCREMENT CHARACTER COUNT
%       #GV7=#GV7+1
%       GOTO 7Ø6
```

```
%       NOTE: GENERATE 02 LEVEL ENTRY
%708    #GFIL='OUTREC'
%       OBEY 102,713
%       NOTE: TEST #GV9 FOR 0-9
%713    TESTDIGT(#GV9)
%       IF #GTST.EQ.0,GOTO 709
                    02 #GV9 PICTURE X(#GV7).
%       GOTO 712
%709    CONTINUE
%       #LV7=#GV7-1
%       IF #LV7.EQ.1,GOTO 777
                    02 A#GV9 PICTURE Z(#LV7)9.
%       GOTO 712
%777    CONTINUE
                    02 A#GV9 PICTURE 9.
%       NOTE: FINISH WRITING TO FILE
%712    CONTINUE
        /1///1///1///1///1///1///1/
%       NOTE: GENERATE MOVE STATEMENTS AND PARAGRAPH NAME IF AT LEVEL L
%       NOTE: TEST FOR 'L' IN #GV4
%       IF #GV4.EQ.'L',GOTO 714
%       NOTE: TEST PARAGRAPH SWITCH #GPSW
%       IF #GPSW.NE.0,GOTO 768
%       #GFIL='OTHERPAR'
%       OBEY 102,716
%716    CONTINUE
              #GV4-TOTALS.
%       #GPSW=1
        /1///1///1///1///1///1///1/
%768    IF #GMVE.NE.0,GOTO 729
%       #GFIL='OTHERPAR'
%       OBEY 102,717
%717    CONTINUE
                    MOVE CORRESPONDING #GV4-LEVEL TO #GV4-REC#GOCT.
%       #GMVE=1
%       GOTO 718
%714    #GFIL='MOVEPARA'
%       OBEY 102,719
%719    TESTDIGT(#GV9)
%       IF #GTST.EQ.0,GOTO 720
                    MOVE #GV9 IN INREC TO #GV9 IN L-REC#GOCT.
%       GOTO 718
%720    CONTINUE
                    MOVE A#GV9 IN INREC TO A#GV9 IN L-REC#GOCT.
```

```
%       NOTE: TEST #LV2 FOR END OF INPUT BUFFER
%718    CONTINUE
        /1///1///1///1///1///1///1/
%729    IF #LV2.LE.1,GOTO 703
%       NOTE: TEST FOR CONTROL LEVEL L AND SET FILE NAME IN #GFIL
%       IF #GV4.EQ.'L',GOTO 721
%       #GFIL='OTHERPAR'
%       GOTO 722
%721    #GFIL='WRITEPAR'
%722    OBEY 102,725
%       NOTE: GENERATE WRITE STATEMENTS
%725    IF #GOCT.EQ.1,GOTO 723
                    PERFORM PARA-LINE-CHECK THRU PARA-LINE-EXIT.
                    WRITE OUTREC FROM #GV4-REC#GOCT AFTER ADVANCING 1.
                    ADD 1 TO LINE-COUNT.
%       GOTO 724
%723    CONTINUE
                    PERFORM PARA-LINE-CHECK THRU PARA-LINE-EXIT.
                    WRITE OUTREC FROM #GV4-REC#GOCT AFTER ADVANCING #GV5.
                    ADD #GV5 TO LINE-COUNT.
%       IF #GV4.EQ.'L',GOTO 724
                    PERFORM #GV4-ADD.
%       NOTE: TEST FOR END OF LEVEL
%724    CONTINUE
        /1///1///1///1///1///1///1/
%       IF #LV2.LE.2,GOTO 767
%       NOTE: GENERATE FINAL SPACING STATEMENT
%       CALLCONV(#GV6,#GV6)
%       IF #GV6.LE.0,GOTO 730
%       IF #GV4.EQ.'L',GOTO 726
%       #GFIL='OTHERPAR'
%       GOTO 727
%726    #GFIL='WRITEPAR'
%727    OBEY 102,728
%728    CONTINUE
                    MOVE SPACES TO OUTREC.
                    WRITE OUTREC AFTER ADVANCING #GV6.
                    ADD #GV6 TO LINE-COUNT.
        /1///1///1///1///1///1///1/
%730    CALLFSTR(#LV1,1,4)
%       IF #LV1.EQ.'*OUT', GOTO 701
%       GOTO 10
%       NOTE: PROCESS LITERAL FIELD
%705    RESET #S49
```

```
%       #GV7=0
%       NOTE: EXTRACT NEXT CHARACTER AND TEST FOR QUOTE
%733    #LV3=732
%       GOTO 760
%732    IF #LV1.EQ.#GQUO,GOTO 734
%       DEPOSIT9 #LV1\
%       #GV7=#GV7+1
%       GOTO 733
%       NOTE: GENERATE FILLER CONTAINING LITERAL
%734    #GFIL='OUTREC'
%       #GV7=#GV7+2
%       OBEY 102,735
%735    CONTINUE
                    02 FILLER PICTURE X(#GV7) VALUE '' #S49 ''.
%       #LV3=718
%       GOTO 760
%       NOTE: PROCESS BLANK FIELD
%704    #GV7=1
%       NOTE: EXTRACT NEXT CHARACTER
%740    #LV3=736
%       GOTO 760
%       NOTE: TEST FOR END OF INPUT BUFFER
%736    IF #LV2.GT.1,GOTO 737
%       NOTE: TEST FOR BLANK CHARACTER IN #LV1
%       IF #LV1.EQ.' ',GOTO 738
%       NOTE: GENERATE BLANK FILLER
%737    #GFIL='OUTREC'
%       OBEY 102,739
%739    CONTINUE
                    02 FILLER PICTURE X(#GV7) VALUE SPACES.
%       GOTO 718
%       NOTE: INCREMENT BLANK CHARACTER COUNT
%738    #GV7=#GV7+1
%       GOTO 740
%       NOTE: ROUTINE TO EXTRACT CHARACTERS FROM *OUT PARAMETER RECORDS
%760    IF #LV2.NE.0,GOTO761
%       IF #GINP.GT.72,GOTO 762
%       NOTE: FETCH NEXT CHARACTER
%764    CALLFSTR(#LV1,0,1)
%       #GINP=#GINP+1
%763    GOTO #LV3
%761    IF #GINP.GT.48,GOTO 765
%       GOTO 764
%765    READ
%       #GINP=1
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 766
%       #LV2=2
%       GOTO 763
%766    #LV2=3
%       GOTO 763
%762    READ
%       #GINP=1
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'*',GOTO 766
%       #LV2=1
%       GOTO 764
```

10. *GO PROCESSING

```
%       NOTE: ROUTINE FOR PROCESSING *GO DIRECTIVES AND FOR
%       NOTE: MORE COBOL STATEMENTS FOR THE PROCEDURE DIVISION
%       NOTE: IF NOTE PARAGRAPH HAS BEEN GENERATED ADD FINAL
%       NOTE: FULLSTOP
%8      IF #GS01.EQ.0,GOTO 801
%       #GFIL='NOTEPARA'
%       OBEY 102,802
%802    CONTINUE
        /1///1///1///1///1///1///1/
%       NOTE: GENERATE PERFORM STATEMENTS FOR COBOL NEW PAGE
%       NOTE: PROCEDURES
%801    IF 'L'.IN.#GHED,GOTO 804
%805    IF 'R'.IN.#GHED,GOTO 806
%807    IF 'Q'.IN.#GHED,GOTO 808
%809    IF 'P'.IN.#GHED,GOTO 810
%811    IF 'O'.IN.#GHED,GOTO 812
%813    IF 'N'.IN.#GHED,GOTO 814
%815    IF 'M'.IN.#GHED,GOTO 816
%       GOTO 818
%804    #LV1='L'
%       #LV3=805
%       GOTO 819
%806    #LV1='R'
%       #LV3=807
%       GOTO 819
%808    #LV1='Q'
%       #LV3=809
%       GOTO 819
%810    #LV1='P'
%       #LV3=811
%       GOTO 819
%812    #LV1='O'
%       #LV3=813
%       GOTO 819
%814    #LV1='N'
%       #LV3=815
%       GOTO 819
%816    #LV1='M'
%       #LV3=818
%819    #GFIL='PAGEPARA'
```

```
%       #GS13=1
%       OBEY 102,803
%803    CONTINUE
                    PERFORM #LV1-HEAD THRU #LV1-HEAD-EXIT.
        /1///1///1///1///1///1///1/
%       #GFIL='OTHERPAR'
%       OBEY 102,878
%878    CONTINUE
              #LV1-HEAD.
                  PERFORM PARA-LINE-CHECK THRU PARA-LINE-EXIT.
                  IF PAGE-SWITCH NOT EQUAL TO ZERO GO TO #LV1-HEAD-EXIT.

                  PERFORM #LV1-HEAD-WRITE.
              #LV1-HEAD-EXIT. EXIT
        /1///1///1///1///1///1///1/
%       GOTO #LV3
%       NOTE: GENERATE COBOL STATEMENTS FOR PROCESSING CONTROL TOTALS
%818    IF 'M'.IN.#GOUT,GOTO 822
%823    IF 'N'.IN.#GOUT,GOTO 824
%825    IF 'O'.IN.#GOUT,GOTO 826
%827    IF 'P'.IN.#GOUT,GOTO 828
%829    IF 'Q'.IN.#GOUT,GOTO 830
%831    IF 'R'.IN.#GOUT,GOTO 832
%833    IF 'F'.IN.#GOUT,GOTO 834
%       GOTO 860
%822    #LV1='M'
%       #LV2='N'
%       #LV3=823
%       GOTO 840
%824    #LV1='N'
%       #LV2='O'
%       #LV3=825
%       GOTO 840
%826    #LV1='O'
%       #LV2='P'
%       #LV3=827
%       GOTO 840
%828    #LV1='P'
%       #LV2='Q'
%       #LV3=829
%       GOTO 840
%830    #LV1='Q'
%       #LV2='R'
%       #LV3=831
%       GOTO 840
%832    #LV1='R'
%       #LV3=833
```

```
%       GOTO 840
%834    #LV1='F'
%       #LV3=860
%840    #GFIL='FINALPAR'
%       #GS12=1
%       OBEY 102,835
%835    CONTINUE
                    PERFORM #LV1-TOTALS.
        /1//1//1//1//1//1//1//1/
%       IF #LV1.EQ.'F',GOTO 860
%       #GFIL='OTHERPAR'
%       OBEY 102,837
%837    CONTINUE
                #LV1-ADD.
%       IF #LV1.EQ.'R',GOTO 838
%       IF #LV2.IN.#GOUT,GOTO 844
%838    IF 'F'.IN.#GOUT,GOTO 845
%848    CONTINUE
                    SUBTRACT CORRESPONDING #LV1-LEVEL FROM #LV1-LEVEL.
        /1//1//1//1//1//1//1//1/
%       GOTO #LV3
%844    CONTINUE
                    ADD CORRESPONDING #LV1-LEVEL TO #LV2-LEVEL.
%       GOTO 838
%845    CONTINUE
                    ADD CORRESPONDING #LV1-LEVEL TO F-LEVEL.
%       GOTO 848
%       NOTE: GENERATE COBOL STATEMENTS FOR CONTROL
%       NOTE: BREAK PROCESSING
%860    #GFIL='BREAKPAR'
%       OBEY 102,839
%839    CONTINUE
                PARA-BREAK.
%       IF 'R'.IN.#GOUT,GOTO 851
%852    IF 'Q'.IN.#GOUT,GOTO 853
%854    IF 'P'.IN.#GOUT,GOTO 855
%856    IF 'O'.IN.#GOUT,GOTO 857
%858    IF 'N'.IN.#GOUT,GOTO 859
%862    IF 'M'.IN.#GOUT,GOTO 861
                    EXIT.
%868    GOTO 865
%851    #LV1='R'
%       #LV2='Q'
%       #LV3=852
%       GOTO 863
%853    #LV1='Q'
```

```
%       #LV2='P'
%       #LV3=853
%       GOTO 863
%855    #LV1='P'
%       #LV2='O'
%       #LV3=856
%       GOTO 863
%857    #LV1='O'
%       #LV2='N'
%       #LV3=858
%       GOTO 863
%859    #LV1='N'
%       #LV2='M'
%       #LV3=862
%       GOTO 863
%861    #LV1='4'
%       #LV3=868
%863    IF #LV1.NE.'M',GOTO 847
                    IF M IN INREC EQUALS M IN CONTROL-BREAK
                    GO TO PARA-BREAK-EXIT.
%       GOTO 849
%847    CONTINUE
                    IF #LV1 IN INREC EQUALS #LV1 IN CONTROL-BREAK
                    GO TO #LV2-BREAK.
%849    OBEY 870,841
%841    OBEY 880,842
%842    OBEY 890,843
%843    GOTO #LV3
%       NOTE: GENERATE PERFORM TOTALS STATEMENTS
%870    IF 'M'.IN.#GOUT,GOTO 871
%869    IF 'N'.IN.#GOUT,GOTO 872
%879    IF 'O'.IN.#GOUT,GOTO 873
%888    IF 'P'.IN.#GOUT,GOTO 874
%889    IF 'Q'.IN.#GOUT,GOTO 875
%899    IF 'R'.IN.#GOUT,GOTO 876
%       GOTO 877
%871    CONTINUE
                    PERFORM M-TOTALS.
%       IF #LV1.EQ.'M',GOTO 877
%       GOTO 869
%872    CONTINUE
                    PERFORM N-TOTALS.
%       IF #LV1.EQ.'N',GOTO 877
%       GOTO 879
%873    CONTINUE
                    PERFORM O-TOTALS.
```

```
%       IF #LV1.EQ.'O',GOTO 877
%       GOTO 888
%874    CONTINUE
                    PERFORM P-TOTALS.
%       IF #LV1.EQ.'P',GOTO 877
%       GOTO 889
%875    CONTINUE
                    PERFORM Q-TOTALS.
%       IF #LV1.EQ.'Q',GOTO 877
%       GOTO 899
%876    CONTINUE
                    PERFORM R-TOTALS.
%877    RETURN
%       NOTE:  GENERATE MOVE STATEMENT(S) TO UPDATE CONTROL FIELDS
%880    IF #LV1.EQ.'R',GOTO 881
%       IF #LV1.EQ.'Q',GOTO 882
%       IF #LV1.EQ.'P',GOTO 883
%       IF #LV1.EQ.'O',GOTO 884
%       IF #LV1.EQ.'N',GOTO 885
%       IF #LV1.EQ.'M',GOTO 886
%       GOTO 887
%881    CONTINUE
                    MOVE R IN INREC TO R IN CONTROL-BREAK.
%882    CONTINUE
                    MOVE Q IN INREC TO Q IN CONTROL-BREAK.
%883    CONTINUE
                    MOVE P IN INREC TO P IN CONTROL-BREAK.
%884    CONTINUE
                    MOVE O IN INREC TO O IN CONTROL-BREAK.
%885    CONTINUE
                    MOVE N IN INREC TO N IN CONTROL-BREAK.
%886    CONTINUE
                    MOVE M IN INREC TO M IN CONTROL-BREAK.
%887    RETURN
%       NOTE: GENERATE PERFORM VERBS FOR CONTROL HEADINGS
%890    IF 'F'.EQ.#LV1,GOTO 891
%       IF 'R'.EQ.#LV1,GOTO 892
%       IF 'Q'.EQ.#LV1,GOTO 893
%       IF 'P'.EQ.#LV1,GOTO 894
%       IF 'O'.EQ.#LV1,GOTO 895
%       IF 'N'.EQ.#LV1,GOTO 896
%       IF 'M'.EQ.#LV1,GOTO 897
%       GOTO 898
%891    IF 'F'.IN.#GHED,GOTO 900
%       GOTO 892
%900    CONTINUE
```

```
                    PERFORM F-HEAD THRU F-HEAD-EXIT.
%
 892   IF 'R'.IN.#GHED,GOTO 901
%      GOTO 893
%901   CONTINUE
                    PERFORM R-HEAD THRU R-HEAD-EXIT.
%893   IF 'Q'.IN.#GHED,GOTO 902
%      GOTO 894
%902   CONTINUE
                    PERFORM Q-HEAD THRU Q-HEAD-EXIT.
%894   IF 'P'.IN.#GHED,GOTO 903
%      GOTO 895
%903   CONTINUE
                    PERFORM P-HEAD THRU P-HEAD-EXIT.
%895   IF 'O'.IN.#GHED,GOTO 904
%      GOTO 896
%904   CONTINUE
                    PERFORM O-HEAD THRU O-HEAD-EXIT.
%896   IF 'N'.IN.#GHED,GOTO 905
%      GOTO 897
%905   CONTINUE
                    PERFORM N-HEAD THRU N-HEAD-EXIT.
%897   IF 'M'.IN.#GHED,GOTO 906
%      GOTO 898
%906   CONTINUE
                    PERFORM M-HEAD THRU M-HEAD-EXIT.
%898   IF #LV1.EQ.'M',GOTO 867
                    GO TO PARA-BREAK-EXIT.
              #LV2-BREAK.
%867   RETURN
%865   CONTINUE
              PARA-BREAK-EXIT. EXIT.
%864   CONTINUE
       /1///1///1///1///1///1///1/
%      NOTE: GENERATE STEERING LINES FOR PART1 MACRO
       /1/FILE,0,PART1\
       /1/DEF  PART1
       *IDENTITY #GV2
       *COMPILE
       *COBOL CARDS (TABNCRDS)
       *OBJECT EDS (ICLA-DEFAULT)
       *STANDARD
       *CONSOLIDATE EDS XPCK
       *SUBGROUPS EDS (SUBGROUPS-RS)
       *LOAD
```

```
        *LIST S P
        /1/END
        /1///1///1///1///1///1///1/
%       NOTE: COMPLETE GENERATION OF CONSTANTS MACRO
        /1/FILE,1,CONSTANTS\
        /1/       #GHATCGHED=#GQUO#GHED#GQUO
        /1/       #GHATCGOUT=#GQUO#GOUT#GQUO
        /1/       #GHATCGV2=#GQUO#GV2#GQUO
        /1/       #GHATCGV11=#GQUO#GV11#GQUO
        /1/       #GHATCGV12=#GQUO#GV12#GQUO
        /1/       #GHATCGS01=#GS01
        /1/       #GHATCGS03=#GS03
        /1/       #GHATCGS12=#GS12
        /1/       #GHATCGS15=#GS15
        /1/       #GHATCGVZ=#GVZ
        /1/END
        /1///1///1///1///1///1///1/
%       NOTE: COMPLETE GENERATION OF MACROS
%       #GFIL='NOTEPARA'
%       OBEY 104,30
%30     #GFIL='TITLES'
%       OBEY 104,31
%31     #GFIL='TITLEPAR'
%       OBEY 104,32
%32     #GFIL='OTHERPAR'
%       OBEY 104,33
%33     #GFIL='HEADINGS'
%       OBEY 104,34
%34     #GFIL='INPUTREC'
%       OBEY 104,35
%35     #GFIL='CTRLBRKE'
%       OBEY 104,36
%36     #GFIL='SAVETOTL'
%       OBEY 104,37
%37     #GFIL='WRITEPAR'
%       OBEY 104,38
%38     #GFIL='MOVEPARA'
%       OBEY 104,39
%39     #GFIL='OUTREC'
%       OBEY 104,40
%40     #GFIL='FINALPAR'
%       OBEY 104,41
%41     #GFIL='PAGEPARA'
%       OBEY 104,42
%42     #GFIL='BREAKPAR'
%       OBEY 104,43
%43     #GFIL='ADDPARA'
%       OBEY 104,44
%44     GOTO 9999
```

11. MESSAGES AND CREATE SUBFILES

CATALOGUE CREATION MACRO.
THIS MACRO CREATES AN EMPTY CATALOGUE AND ESTABLISHES THE SECURITY SYSTEM FOR PROTECTING ACCESS TO THE FILE DESCRIPTIONS WHICH THE CATALOGUE WILL EVENTUALLY CONTAIN.
PLEASE TYPE THE PASSWORD TO BE USED BY PERSONS ENTITLED TO AMEND THE CATALOGUE. THE PASSWORD MAY BE UP TO 8 CHARACTERS LONG AND THE DEFAULT VALUE IS BLANK. CHARACTERS IN EXCESS OF 8 WILL BE IGNORED.
PLEASE TYPE THE NUMBER OF SECURITY LEVELS BY WHICH ACCESS TO FILE DATA IS TO BE PROTECTED. THE NUMBER MUST BE GREATER THAN ZERO AND LESS THAN 13. THE DEFAULT REPLY IS 12.

```
%DEF   CREATE
%      NOTE: MACRO TO CREATE AN EMPTY CATALOGUE FOR DESCRIPTIONS OF
%      NOTE: FILES WITHIN THE DATA BASE
%      NOTE: IDENTIFY THE MACRO TO THE USER AND REQUEST THE CATALOGUE
%      NOTE: PASSWORD
%      #LSTRT=1
%      #LFIN=7
%      CALL 1
%      NOTE: READ AND EXTRACT PASSWORD FOR CATALOGUE
%      CALL 9
%      CALLFSTR(#GPASS,1,8)
%      NOTE: REQUEST NO. OF SECURITY LEVELS TO BE USED
%      #LSTRT=8
%      #LFIN=10
%      CALL 1
%      NOTE: READ AND VALIDATE SECURITY LEVELS
%2     CALL 9
%      SQUASH
%      IF #GSTC.EQ.0,GOTO 3
%      IF #GSTC.GT.2,GOTO 4
%      NOTE: TEST FIRST CHARACTER FOR DIGIT
%      CALLFSTR(#LV1,1,1)
%      TESTDIGT(#LV1)
%      IF #GTST.NE.0,GOTO 4
%      NOTE: TEST SECOND CHARACTER IF PRESENT FOR DIGIT
%      IF #GSTC.EQ.1,GOTO 5
%      CALLFSTR(#LV1,2,1)
%      TESTDIGT(#LV1)
%      IF #GTST.NE.0,GOTO 4
%      NOTE: EXTRACT TWO VALID DIGITS
%      CALLFSTR(#LV1,1,2)
%      NOTE: CONVERT #LV1 TO BINARY
%5     CALLCONV(#LV1,#LV1)
%      IF #LV1.LT.1,GOTO 4
%      IF #LV1.GT.12,GOTO 4
%      NOTE: SET UP AND WRITE CATALOGUE CONTROL RECORD
%6     DATE
%      TIME
%      RESET #S01
%      DEPOSIT1 0,1,#GPASS,#LV1,#GCDT,#GCTM,\
%      SELECT CATALOGUE
%      REPLACE 1,#S01
%      NOTE: WRITE END OF JOB MESSAGE
%      DEPOSIT0 EMPTY%CATALOGUE%WITH%#LV1%SECURITY%LEVELS%CREATED%ON\
%      WRITE
%      DEPOSIT0 #GCDT%AT%#GCTM%AND%READY%FOR%USE.\
%      WRITE
%      GOTO 999
%      NOTE: ROUTINE TO PRINT RECORDS FROM THE MESSAGE FILE
%1     SELECT MESSAGES
%7     FREAD #LSTRT,#S01
%      DEPOSIT0 #S01\
%      WRITE
%      #LSTRT=#LSTRT+1
%      IF #LSTRT.LE.#LFIN,GOTO 7
%      EXIT
%      NOTE: SET DEFAULT NO. OF SECURITY LEVELS TO BE 12
%3     #LV1=12
%      GOTO 6
%      NOTE: SECURITY LEVEL ERROR
%4     WRITE #S01
%      DEPOSIT0 #S01%INVALID%SECURITY%LEVEL.%PLEASE%ENTER%CORRECT%VALUE.\

%      WRITE
%      GOTO 2
%      NOTE: ISSUE PROMPT AND READ REPLY
%9     DEPOSIT0 :\
%      WRITE
%      READ
%      EXIT
%999   CONTINUE
%END
```

12. PASSCHANGE SUBFILE

```
%DEF   PASSCHANGE
%      NOTE: MACRO TO ALLOW THE CATALOGUE PASSWORD TO BE CHANGED
%      NOTE: INTRODUCE MACRO AND REQUEST OLD PASSWORD
%      DEPOSITØ MACRO%TO%CHANGE%CATALOGUE%PASSWORD.\
%      WRITE
%      DEPOSITØ PLEASE%TYPE%THE%OLD%PASSWORD.\
%      WRITE
%      NOTE: READ AND VALIDATE OLD PASSWORD
%      CALL 9000
%      CALLFSTR(#GOLD,1,8)
%      NOTE: READ CATALOGUE CONTROL RECORD FROM SUBFILE
%      SELECT CATALOGUE
%      FREAD 1,#SØ1
%      NOTE: EXTRACT FILE AND RECORD COUNTS
%      READ #SØ1
%      CALLVSTR(#LV1,1,,)
%      #GINP=#GCCT+2
%      CALLVSTR(#LV2,Ø,,)
%      NOTE: EXTRACT SUBFILE PASSWORD
%      #GINP=#GINP+#GCCT+1
%      CALLFSTR(#GOLDC,Ø,8)
%      NOTE: EXTRACT NO. OF SECURITY LEVELS
%      #GINP=#GINP+9
%      CALLVSTR(#LV3,Ø,,)
%      NOTE: COMPARE PASSWORDS
%      IF #GOLD.EQ.#GOLDC,GOTO 1Ø
%      NOTE: PASSWORD IN ERROR. TERMINATE RUN.
%      DEPOSITØ #GOLD%IS%AN%INVALID%PASSWORD.%TASK%ABANDONED.\
%      WRITE
%      GOTO 1ØØ
%      NOTE: ISSUE PROMPT AND READ REPLY
%9ØØØ  DEPOSITØ :\
%      WRITE
%      READ
%      EXIT
%      NOTE: REQUEST NEW PASSWORD
%1Ø    DEPOSITØ PLEASE%TYPE%THE%NEW%PASSWORD%OF%UP%TO%8%CHARACTERS.\
%      WRITE
%      NOTE: READ AND EXTRACT NEW PASSWORD
%      CALL 9000
%      CALLFSTR(#GPASS,1,8)
%      NOTE: UPDATE CONTROL RECORD ON CATALOGUE
%      DATE
%      TIME
%      RESET #SØ1
%      DEPOSIT1 #LV1,#LV2,#GPASS,#LV3,#GCDT,#GCTM,\
%      REPLACE 1,#SØ1
%      NOTE: WRITE JOB COMPLETE MESSAGE
%      DEPOSITØ NEW%PASSWORD%IN%OPERATION%ON%#GCDT%AT%#GCTM.\
%      WRITE
%1ØØ   CONTINUE
%END
```

13. LIBRARIAN SUBFILE

```
%DEF   LIBRARIAN
%      NOTE: #GFCT = COUNT OF FILES IN CATALOGUE
%      NOTE: #GRCT = COUNT OF RECORDS IN CATALOGUE
%      NOTE: #GREC = CURRENT RECORD POINTER
%      NOTE: #S09 = FILE NAME
%      NOTE: #GCATP = CATALOGUE PASSWORD
%      NOTE: #GPW01 = HIGHEST SECURITY LEVEL PASSWORD FOR FILE
%      NOTE: #GFERR = FILENAME ERROR INDICATOR
%      NOTE: #GPERR = PASSWORD ERROR INDICATOR
%      NOTE: #GNERR = ERROR INDICATOR FOR AN INVALID COBOL NAME
%      NOTE: #GSLVL = NO. OF SECURITY LEVELS USED TO PROTECT DATA ACCESS

%      NOTE: SELECT CATALOGUE SUBFILE
%      SELECT CATALOGUE
%      NOTE: READ CATALOGUE CONTROL RECORD IN TO #S01
%      FREAD 1,#S01
%      NOTE: EXTRACT FILE COUNT, RECORD COUNT, PASSWORD AND NO. OF
%      NOTE: SECURITY LEVELS
%      READ #S01
%      CALLVSTR(#GFCT,1,,)
%      #GINP=#GCCT+2
%      CALLVSTR(#GRCT,0,,)
%      #GINP=#GINP+#GCCT+1
%      CALLVSTR(#GCATP,0,,)
%      #GINP=#GINP+#GCCT+1
%      CALLVSTR(#GSLVL,0,,)
%      NOTE: CONVERT NUMERIC FIELDS TO BINARY
%      CALLCONV(#GFCT,#GFCT)
%      CALLCONV(#GRCT,#GRCT)
%      CALLCONV(#GSLVL,#GSLVL)
%      NOTE: SET UP SECURITY LEVEL CHECK LIST IN #S08
%      RESET #S08
%      #LV1=1
%105   DEPOSIT8 #LV1,\
%      #LV1=#LV1+1
%      IF #LV1.LE.#GSLVL,GOTO 105
%      NOTE: INTRODUCE MACRO AND REQUEST CATALOGUE PASSWORD
%      DEPOSIT0 CATALOGUE%LIBRARIAN.\
%      WRITE
%      DEPOSIT0 THIS%MACRO%UPDATES%THE%DATABASE%CATALOGUE%OF%FI\
%      CALLCOPY(48,LE%DESCRIPTIONS.)
%      WRITE
%      DEPOSIT0 PLEASE%ENTER%THE%CATALOGUE%PASSWORD\
%      WRITE
%      NOTE: READ AND VALIDATE PASSWORD
%      DEPOSIT0 :\
%      WRITE
%      READ
%      CALLFSTR(#LCATP,1,8)
%      IF #LCATP.NE.#GCATP,GOTO 101
%103   CONTINUE
       [CHAIN0,LIBPRELIM]
       [LIBPRELIM]
%      GOTO 999
%      NOTE: INVALID CATALOGUE PASSWORD
%101   DEPOSIT0 #LCATP%IS%AN%INVALID%PASSWORD.%RUN%TERMINATED.\
%      WRITE
%999   CONTINUE
%END
```

14. LIBPRELIM SUBFILE

```
%DEF   LIBPRELIM
%      NOTE: REQUEST OPTION - ADD OR DELETE
%100   DEPOSIT0 DO%YOU%WISH%TO%ADD%A%NEW%FILE%DESCRIPTION%OR%DELETE%AN%E\

%      CALLCOPY(57,XISTING%ONE?)
%      WRITE
%104   DEPOSIT0 PLEASE%TYPE%ADD%OR%DELETE,%AT%END%TYPE%FINISH.\
%      WRITE
%      NOTE: READ AND VALIDATE OPTION
%      NOTE: OPTION NOT MORE THAN 6 CHARACTERS AND EQUAL TO ADD OR DELETE

%      CALL 9000
%      SQUASH
%      #GOUP=#GSTC
%      CALLFSTR(#GOPT,1,0)
%      #GOUP=1
%      IF #GSTC.GT.6,GOTO 102
%      IF #GOPT.EQ.'ADD',GOTO 103
%      IF #GOPT.EQ.'DELETE',GOTO 103
%      IF #GOPT.EQ.'FINISH',GOTO  EXIT
%      NOTE: INVALID OPTION
%102   DEPOSIT0 #GOPT%IS%AN%INVALID%RESPONSE\
%      WRITE
%      GOTO 104
%      NOTE: REQUEST FILENAME
%103   DEPOSIT0 PLEASE%TYPE%THE%NAME%OF%THE%FILE%WHOSE%DESCRIPTION%YOU\
%      WRITE
%      DEPOSIT0 WISH%TO%#GOPT.\
%      WRITE
%      NOTE: READ AND STORE FILENAME
%      CALL 9000
%      WRITE #S09
%      NOTE: VALIDATE FILENAME OF UP TO 30 CHARACTERS
%      #GLENG=30
%      CALL 200
%      NOTE: TEST NAME ERROR INDICATOR
%      IF #GNERR.EQ.0,GOTO 300
%      NOTE: INVALID FILENAME
```

```
%       DEPOSIT0 FILE%NAME%#S09%INVALID%FOR%REASON%LISTED%ABOVE\
%       WRITE
%       GOTO 103
%       NOTE: VALIDATE NAME STARTING IN POSITION 1 OF INPUT BUFFER
%       NOTE: #GNERR = ERROR INDICATOR
%       NOTE: CLEAR ERROR INDICATOR
%200    #GNERR=0
%       NOTE: TEMPORARILY SAVE CONTENTS OF INPUT BUFFER
%       WRITE #S01
%       NOTE: CHECK NO. OF CHARACTERS
%       SQUASH
%       IF #GSTC.GT.#GLENG,GOTO 202
%       NOTE: CHECK FOR IMBEDDED BLANKS
%       WRITE #S02
%       IF #S01.NE.#S02,GOTO 203
%       NOTE: CHECK FIRST CHARACTER FOR HYPHEN OR Z
%210    CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'Z-',GOTO 204
%       NOTE: CHECK LAST CHARACTER FOR HYPHEN
%211    #GINP=#GSTC
%       CALLFSTR(#LV1,0,1)
%       IF #LV1.EQ.'-',GOTO 205
%       NOTE: SET UP LOOP TO CHECK FOR ALPHABETIC, NUMERIC AND HYPHEN ONLY

%212    #GINP=1
%       NOTE: ZEROISE COUNT OF ALPHA CHARACTERS

%       #LALPH=0
%       NOTE: EXTRACT NEXT CHARACTER
%213    CALLFSTR(#LV1,0,1)
%       NOTE: TEST NUMERIC
%       TESTDIGT(#LV1)
%       IF #GTST.EQ.0,GOTO 206
%       NOTE: TEST ALPHABETIC
%       TESTLETR(#LV1)
%       IF #GTST.EQ.0,GOTO 207
%       NOTE: TEST HYPHEN
%       IF #LV1.EQ.'-',GOTO 206
%       NOTE: INVALID CHARACTER FOUND
%       DEPOSIT0 #LV1%INVALID%CHARACTER,%ONLY%A%TO%Z,%0%TO%9%AND%-%ALLOWE\

%       CALLCOPY(54,D)
%       WRITE
%       NOTE: SET ERROR INDICATOR ON
%       #GNERR=1
%       NOTE: UPDATE POINTER AND TEST FOR END OF LOOP
%206    #GINP=#GINP+1
%       IF #GINP.GT.#GSTC,GOTO 214
%       GOTO 213
%       NOTE: TEST FOR AT LEAST ONE ALPHA CHARACTER
%214    IF #LALPH.GT.0,GOTO 208
%       NOTE: NO ALPHA CHARACTER PRESENT
%       DEPOSIT0 AT%LEAST%ONE%ALPHABETIC%CHARACTER%MUST%BE%INCLUDED\
%       WRITE
%       #GNERR=1
```

```
%208   EXIT
%      NOTE: MORE THAN PERMITTED CHARACTERS IN NAME
%202   DEPOSIT0 MORE%THAN%#GLENG%CHARACTERS%IN%NAME\
%      WRITE
%      #GNERR=1
%      GOTO 209
%      NOTE: BLANKS NOT ALLOWED
%203   DEPOSIT0 BLANKS%NOT%ALLOWED\
%      WRITE
%      #GNERR=1
%      GOTO 210
%      NOTE: FIRST CHARACTER HYPHEN OR Z
%204   DEPOSIT0 Z%OR%-%NOT%ALLOWED%AS%FIRST%CHARACTER\
%      WRITE
%      #GNERR=1
%      GOTO 211
%      NOTE: LAST CHARACTER HYPHEN
%205   DEPOSIT0 -%NOT%ALLOWED%AS%LAST%CHARACTER\
%      WRITE
%      #GNERR=1
%      GOTO 212
%      NOTE: ADD 1 TO ALPHABETIC COUNT
%207   #LALPH=#LALPH+1
%      GOTO 206
%      NOTE: REQUEST TOP SECURITY LEVEL PASSWORD
%300   DEPOSIT0 PLEASE%TYPE%PASSWORD%FOR%TOP%SECURITY%LEVEL%FOR%FILE\
%      WRITE
%      DEPOSIT0 #S09\
%      WRITE
%      CALL 9000

%      CALLFSTR(#GPW01,1,8)
%      NOTE: SEARCH CATALOGUE FOR FILE
%      NOTE: #S09 CONTAINS FILENAME
%      NOTE: #GPW01 CONTAINS 8 CHARACTER PASSWORD
%      NOTE: #GFERR IS FILENAME ERROR INDICATOR
%      NOTE: #GPERR IS PASSWORD ERROR INDICATOR
%      NOTE: #GREC IS CATALOGUE RECORD POINTER
%      NOTE: #GFDCT IS FIELD COUNT FOR CURRENT FILE
%      NOTE: #S01 AND INPUT BUFFER USED AS WORK AREAS
%      NOTE: #GFCT IS FILE COUNT
%      NOTE: #S02 IS FILENAME FROM CATALOGUE
%      NOTE: #LPW01 IS FILE PASSWORD FROM CATALOGUE
%      NOTE: CLEAR ERROR INDICATORS
%      SELECT CATALOGUE
%      #GPERR=0
%      #GFERR=0
%      NOTE: SET RECORD POINTER FOR FIRST FILE
%      #GREC=2
%      #LFCT=#GFCT
```

```
%       NOTE: TEST IF ALL FILES SEARCHED
%401    IF #LFCT.EQ.0,GOTO 402
%       NOTE: READ FILENAME RECORD
%       FREAD #GREC,#S01
%       NOTE: EXTRACT FILENAME FROM #S01
%       VSTR2 #S01,1,,
%       NOTE: PLACE RECORD IN INPUT BEFFER
%       READ #S01
%       NOTE: UPDATE INPUT BUFFER POINTER
%       #GINP=#GCCT+2
%       NOTE: EXTRACT FIELD COUNT AND CONVERT TO BINARY
%       CALLVSTR(#GFDCT,0,,)
%       CALLCONV(#GFDCT,#GFDCT)
%       NOTE: TEST FOR REQUIRED FILE
%       IF #S09.GT.#S02,GOTO 403
%       IF #S09.LT.#S02,GOTO 402
%       NOTE: UPDATE INPUT BUFFER POINTER
%       #GINP=#GINP+#GCCT+1
%       NOTE: EXTRACT TOP SECURITY LEVEL PASSWORD
%       CALLFSTR(#LPW01,0,8)
%       NOTE: TEST FOR VALID PASSWORD
%       IF #LPW01.EQ.#GPW01,GOTO 301
%       NOTE: SET INVALID PASSWORD INDICATOR
%       #GPERR=1
%       GOTO 301
%       NOTE: ISSUE PROMPT AND READ REPLY
%9000 DEPOSIT0 :\
%       WRITE
%       READ
%       EXIT
%       NOTE: UPDATE FILE RECORD POINTER
%403    #GREC=#GREC+#GFDCT+#GFDCT+3
%       IF #GSLVL.LE.4,GOTO 404
%       #GREC=#GREC+1
%       NOTE: REDUCE FILE COUNT
%404    #LFCT=#LFCT-1
%       GOTO 401
%       NOTE: SET FILE NAME ERROR INDICATOR ON
%402    #GFERR=1
%       NOTE: CHAIN TO MACRO SPECIFIED BY USER OPTION
%301    CONTINUE
        [CHAIN0,LIB#GOPT]
        [LIB#GOPT]
%999    CONTINUE
%END
```

15. LIBDELETE SUBFILE

```
%DEF   LIBDELETE
%      NOTE: PROCESS DELETE OPTION
%      NOTE: DELETE FILE DESCRIPTION FROM CATALOGUE
%      NOTE: #GREC IS CATALOGUE FILE RECORD POINTER
%      NOTE: #GFCT IS CATALOGUE FILE COUNT
%      NOTE: #GRCT IS CATALOGUE RECORD COUNT
%      NOTE: #GFERR IS FILENAME ERROR INDICATOR SET BY SEARCH
%      NOTE: #GPERR IS PASSWORD ERROR INDICATOR SET BY SEARCH
%      NOTE: #GFDCT IS COUNT OF FIELDS IN SPECIFIED FILE SET BY SEARCH
%      NOTE: #S01 USED AS TEMPORARY STORAGE
%      SELECT CATALOGUE
(1)    NOTE: TEST FILENAME ERROR INDICATOR
%      IF #GFERR.EQ.1,GOTO 501
(2)    NOTE: TEST PASSWORD ERROR INDICATOR
%      IF #GPERR.NE.0,GOTO 502
(3)    NOTE: #LDREC IS NO. OF RECORDS DELETED
%      #LDREC=#GFDCT+#GFDCT+3
%      IF #GSLVL.LE.4,GOTO 503
(O)    #LDREC=#LDREC+1
%      NOTE: DELETE #LDREC RECORDS STARTING AT #GREC
%503   #LV1=1
%506   DELETE #GREC
%      #LV1=#LV1+1
%      IF #LV1.LE.#LDREC,GOTO 506
%      GOTO 505
%      NOTE: ERROR FILENAME NOT IN CATALOGUE
%501   DEPOSIT0 #S09%IS%NOT%IN%THE%CATALOGUE\
%      WRITE
%      GOTO 100
%      NOTE: PASSWORD ERROR
%502   DEPOSIT0 #GPW01%IS%NOT%AN%ACCEPTABLE%PASSWORD.%REQUEST%CANCELLED.\

%      WRITE
%      GOTO 100
(4)    NOTE: REDUCE FILE COUNT BY 1
%505   #GFCT=#GFCT-1
(O)    NOTE: REDUCE RECORD COUNT
%      #GRCT=#GRCT-#LDREC
%      NOTE: AMEND CATALOGUE CONTROL RECORD
%      DATE
%      TIME
%      RESET #S01
%      DEPOSIT1 #GFCT,#GRCT,#GCATP,#GSLVL,#GCDT,#GCTM,\
%      REPLACE 1,#S01
(5)    DEPOSIT0 CATALOGUE%UPDATED%ON%#GCDT%AT%#GCTM\
%      WRITE
(6)    %100   CONTINUE
       [CHAIN0,LIBPRELIM]
       [LIBPRELIM]
%END
```

16. LIBADD SUBFILE

```
%DEF   LIBADD
%      NOTE: ADD FILE DESCRIPTION TO CATALOGUE
%      NOTE: #S09 CONTAINS FILENAME
%      NOTE: #GPW01 IS TOP SECURITY LEVEL PASSWORD
%      NOTE: #GREC POINTS AT START OF FILE DESCRIPTION
%      NOTE: #GRCT IS NO. OF RECORDS IN CATALOGUE
%      NOTE: #GFCT IS NO. OF FILES IN CATALOGUE
%      NOTE: #GFERR IS FILENAME ERROR INDICATOR
%      NOTE: TEST FOR FILE OF SAME NAME ALREADY IN CATALOGUE
%      SELECT CATALOGUE
%      IF #GFERR.EQ.1,GOTO 700
%      NOTE: FILE NAME ALREADY IN CATALOGUE
%      DEPOSIT0 THERE%IS%ALREADY%A%FILE%CALLED%#S09\
%      WRITE
%      DEPOSIT0 IN%THE%CATALOGUE\
%      WRITE
%100   CONTINUE
       [CHAIN0,LIBPRELIM]
       [LIBPRELIM]
%      GOTO 999
%      NOTE: REQUEST NO. OF FIELDS IN FILE RECORD
%700   DEPOSIT0 PLEASE%TYPE%THE%NUMBER%OF%FIELDS%IN%A%RECORD%OF%FILE\
%      WRITE
%      NOTE: READ AND VALIDATE FIELD COUNT
%      CALL 9000
%      NOTE: NOT MORE THAN 4 DIGITS
%      SQUASH
%      IF #GSTC.GT.4,GOTO 701
%      #GINP=1
%705   CALLFSTR(#LV1,0,1)
%      TESTDIGT(#LV1)
%      IF #GTST.NE.0,GOTO 701
%      #GINP=#GINP+1
%      IF #GINP.LE.#GSTC,GOTO 705
%      #GOUP=#GSTC
%      CALLFSTR(#GFLDS,1,0)
%      CALLCONV(#GFLDS,#GFLDS)
%      #GOUP=1
%      IF #GFLDS.LT.1,GOTO 701
%      NOTE: BUILD UP FILE RECORD TYPE 1
%      RESET #S01
%      DEPOSIT1 #S09,#GFLDS,\
%      NOTE: REQUEST REMAINING PASSWORDS FOR RECORD TYPE 1
```

```
%       #LSLVL=2
%       RESET #S02
%       DEPOSIT2 #GPW01,\
%704    IF #LSLVL.GT.#GSLVL,GOTO 703
%       IF #LSLVL.GT.4,GOTO 703
%       DEPOSIT0 PLEASE%TYPE%THE%PASSWORD%FOR%SECURITY%LEVEL%#LSLVL\
%       WRITE
%       CALL 9000
%       CALLFSTR(#LV1,1,8)
%       IF ',.IN.#LV1,GOTO 702
%       IF #LV1.IN.#S02,GOTO 702
%       DEPOSIT2 #LV1,\
%       #LSLVL=#LSLVL+1
%       GOTO 704
%703    DEPOSIT1 #S02\
%       NOTE: WRITE FILENAME RECORD TYPE 1 IN CATALOGUE
%       INSERT #GREC,#S01
%       NOTE: UPDATE RECORD POINTER
%       #GREC=#GREC+1
%       GOTO 602
%       NOTE: INVALID NO. OF FIELDS
%701    DEPOSIT0 #GFLDS%INVALID%NO.%OF%FIELDS\
%       WRITE
%       GOTO 704
%       NOTE: DUPLICATE PASSWORD
%702    DEPOSIT0 #LV1%INVALID%OR%DUPLICATE%PASSWORD\
%       WRITE
%       GOTO 704
%       NOTE: TEST FOR MORE THAN 4 SECURITY LEVELS
%602    IF #GSLVL.LE.4,GOTO 603
%       GOTO 803
%       NOTE: DUPLICATE PASSWORD
%801    DEPOSIT0 #LV1%INVALID%OR%DUPLICATE%PASSWORD\
%       WRITE
%       GOTO 803
%       NOTE: REQUEST PASSWORDS FOR RECORD TYPE 1C
%       RESET #S02
%803    IF #LSLVL.GT.#GSLVL,GOTO 802
%       DEPOSIT0 PLEASE%TYPE%PASSWORD%FOR%SECURITY%LEVEL%#LSLVL\
%       WRITE
%       CALL 9000
%       CALLFSTR(#LV1,1,8)
%       IF ',.IN.#LV1,GOTO 801
%       IF #LV1.IN.#S01,GOTO 801
%       IF #LV1.IN.#S02,GOTO 801
%       DEPOSIT2 #LV1,\
%       #LSLVL=#LSLVL+1
```

```
%       GOTO 803
%       NOTE: WRITE FILENAME RECORD TYPE 1C IN CATALOGUE
%802    INSERT #GREC,#S02
%       NOTE: UPDATE RECORD POINTER
%       #GREC=#GREC+1
%       NOTE: READ AND PROCESS FILENAME RECORD TYPE 2
%803    DEPOSIT0 PLEASE%TYPE%UP%TO%70%CHARACTERS%OF%DESCRIPTION%ABOUT%FIL\

%       CALLCOPY(57,E)
%       WRITE
%       CALL 9000
%       WRITE #S01
%       INSERT #GREC,#S01
%       #GREC=#GREC+1
%       NOTE: PROCESS FILENAME RECORD TYPE 3
%       RESET #S41
%       NOTE: REQUEST FILE MEDIUM
%       DEPOSIT4 ON%WHICH%STORAGE%MEDIUM%IS%THIS%FILE?\
%       WRITE
%       DEPOSIT4 PLEASE%TYPE%2%CHARACTERS.%MT%FOR%MAGNETIC%TAPE\
%       WRITE
%       DEPOSIT4 CR%FOR%PUNCHED%CARDS.%PT%FOR%PAPER%TAPE\
%       WRITE
%       DEPOSIT4 ED%FOR%EXCHANGEABLE%DISC%STORE\
%       WRITE
%       NOTE: READ AND VALIDATE FILE MEDIUM
%       CALL 9004
%       SQUASH
%       IF #GSTC.GT.2,GOTO 912
%       CALLFSTR(#GMED,1,2)
%       IF #GMED.EQ.'MT',GOTO 901
%       IF #GMED.EQ.'CR',GOTO 901
%       IF #GMED.EQ.'PT',GOTO 901
%       IF #GMED.EQ.'ED',GOTO 901
%912    DEPOSIT4 INVALID%FILE%MEDIUM.%PLEASE%RETYPE%RESPONSE.\
%       WRITE
%       GOTO 904
%       NOTE: SAVE FILE MEDIUM
%901    DEPOSIT1 #GMED,\
%       NOTE: REQUEST AND VALIDATE BLOCKSIZE
%       NOTE: WHICH MUST BE UP TO 4 DIGITS WITH VALUE < OR = 2048
%       DEPOSIT0 PLEASE%ENTER%BLOCKSIZE\
%       WRITE
%904    CALL 9000
%       SQUASH
%       #GOUP=#GSTC
```

```
%       #GINP=1
%910    CALLFSTR(#LV1,0,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.0,GOTO 902
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 910
%       CALLFSTR(#GBLK,1,0)
%       #GOUP=1
%       CALLCONV(#GBLK,#GBLK)
%       IF #GBLK.LT.1,GOTO 902
%       IF #GBLK.GT.2048,GOTO 902
%       NOTE: SAVE BLOCK SIZE
%       DEPOSIT1 #GBLK,\
%       NOTE: REQUEST AND VALIDATE MAXIMUM RECORD SIZE
%       DEPOSIT0 PLEASE%TYPE%MAXIMUM%NO.%OF%CHARACTERS%IN%A%RECORD\
%       WRITE
%903    CALL 9000
%       SQUASH
%       #GINP=1
%905    CALLFSTR(#LV1,0,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.0,GOTO 906
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 905
%       #GOUP=#GSTC
%       CALLFSTR(#GRSZ,1,0)
%       #GOUP=1
%       CALLCONV(#GRSZ,#GRSZ)
%       IF #GRSZ.LT.1,GOTO 906
%       IF #GRSZ.GT.#GBLK,GOTO 906
%       NOTE: SAVE RECORD SIZE
%       DEPOSIT1 #GRSZ,\
%       NOTE: REQUEST FILE LABEL
%       IF #GMED.IN.'EDMT',GOTO 907
%       NOTE: NULL LABEL ETC
%       DEPOSIT1 ,S,,,\
%       GOTO 1008
%       NOTE: INVALID BLOCKSIZE
%902    DEPOSIT0 INVALID%BLOCKSIZE\
%       WRITE
%       GOTO 904
%       NOTE: INVALID RECORD SIZE
%906    DEPOSIT0 INVALID%RECORD%SIZE\
%       WRITE
%       GOTO 903
%907    DEPOSIT0 PLEASE%TYPE%THE%FILE%LABEL%WHICH%MAY%BE%UP%TO%12\
%       WRITE
```

```
%       DEPOSITØ CHARACTERS%LONG.%EXCESS%CHARACTERS%WILL%BE%IGNORED.\
%       WRITE
%       CALL 9000
%       WRITE #SØ3
%       FSTR2 #SØ3,1,12
%       NOTE: SAVE LABEL
%       DEPOSIT1 #SØ2,\
%       NOTE: TEST FOR DISC FILE
%       IF #GMED.NE.'ED',GOTO 1006
%       NOTE: REQUEST ACCESS MODE
%       DEPOSITØ PLEASE%TYPE%ACCESS%MODE%CODE.%S%FOR%SEQUENTIAL\
%       CALLCOPY(47,%R%FOR%RANDOM)
%       WRITE
%1000  CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 1013
%       CALLFSTR(#GMODE,1,1)
%       IF #GMODE.IN.'SR',GOTO 1001
%1013  DEPOSITØ INVALID%ACCESS%MODE\
%       WRITE
%       GOTO 1000
%       NOTE: TEST FOR RANDOM ACCESS
%1001  IF #GMODE.EQ.'R',GOTO 1002
%1006  DEPOSIT1 S,,,\
%       GOTO 1008
%       NOTE: REQUEST ORGANISATION METHOD
%1002  DEPOSITØ PLEASE%TYPE%DISC%ORGANISATION%CODE.%D%FOR%DIRECT\
%       CALLCOPY(49,%I%FOR%INDEXED)
%       WRITE
%1003  CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 1014
%       CALLFSTR(#GORG,1,1)
%       IF #GORG.IN.'DI',GOTO 1004
%1014  DEPOSITØ INVALID%ORGANISATION\
%       WRITE
%       GOTO 1003
%       NOTE: REQUEST SYMBOLIC KEY LENGTH
%1004  DEPOSITØ PLEASE%TYPE%LENGTH%OF%SYMBOLIC%KEY\
%       WRITE
%1007  CALL9000
%       SQUASH
%       #GINP=1
%1009  CALLFSTR(#LV1,Ø,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.Ø,GOTO 1005
```

```
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 1009
%       #GOUP=#GSTC
%       CALLFSTR(#GLSK,1,0)
%       #GOUP=1
%       CALLCONV(#GLSK,#GLSK)
%       IF #GLSK.LT.1,GOTO 1005
%       IF #GLSK.GT.64,GOTO 1005
%       NOTE: SAVE MODE, ORGANISATION AND KEY LENGTH
%       DEPOSIT1 R,#GMODE,#GORG,#GLSK,\
%       GOTO 1008
%       NOTE: INVALID KEY LENGTH
%1005 DEPOSIT0 KEY%LENGTH%MUST%BE%IN%THE%RANGE%1%TO%64\
%       WRITE
%       GOTO 1007
%       NOTE: REQUEST NO. OF KEY FIELDS
%1008 DEPOSIT0 PLEASE%TYPE%NO.%OF%SEQUENCE%KEY%FIELDS\
%       WRITE
%1011 CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 1024
%       CALLFSTR(#GNKEY,1,1)
%       TESTDIGT(#GNKEY)
%       IF #GTST.NE.0,GOTO 1024
%       CALLCONV(#GNKEY,#GNKEY)
%       IF #GNKEY.GT.0,GOTO 1010
%       NOTE: INVALID NO. OF KEYS
%1024 DEPOSIT0 NO.%OF%KEYS%MUST%BE%IN%THE%RANGE%1%TO%9\
%       WRITE
%       GOTO 1011
%       NOTE: SAVE NO. OF KEYS
%1010 DEPOSIT1 #GNKEY,\
%       NOTE: WRITE FILE RECORD TYPE 3 TO CATALOGUE
%       INSERT #GREC,#S01
%       NOTE: UPDATE CATALOGUE RECORD COUNT
%       #GREC=#GREC+1
%       NOTE: SET UP FIELD KEY CHECK LIST IN #S07
%       RESET #S07
%       #LV1=0
%1012 DEPOSIT7 #LV1\
%       #LV1=#LV1+1
%       IF #LV1.LE.#GNKEY,GOTO 1012
%       RESET #S06
%       NOTE: PROCESS FIELD DESCRIPTION RECORDS
%       NOTE: SAVE POINTER TO START OF FIELD DESCRIPTION RECORDS
%       #LRCST=#GREC
%       NOTE: INTRODUCTORY MESSAGE
```

```
%       DEPOSITØ YOU%ARE%ABOUT%TO%BE%ASKED%FOR%DETAILS%OF%FIELDS%WITHIN%\

%       CALLCOPY(56,A%RECORD)
%       WRITE
%       DEPOSITØ WHERE%POSSIBLE%PLEASE%ENTER%FIELD%NAMES%IN%ASCENDING\
%       CALLCOPY(53,%START%POSITION)
%       WRITE
%       DEPOSITØ AS%THIS%MAKES%FOR%MORE%EFFICIENT%PROCESSING\
%       WRITE
%       NOTE: INITIALISE FIELD COUNT
#       #LFLDS=1
%       NOTE: SET VALID NAME LENGTH TO 14
%       #GLENG=14
%       NOTE: REQUEST AND VALIDATE FIELD NAME
%1101 DEPOSITØ PLEASE%TYPE%THE%NAME%OF%FIELD%NO.%#LFLDS\
%       WRITE
%1102 CALL 9000
%       CALL 200
%       IF #GNERR.EQ.Ø,GOTO 1103
%       NOTE: INVALID FIELD NAME
%       DEPOSITØ INVALID%FIELD%NAME.%REASON%SPECIFIED%ABOVE.\
%       WRITE
%       GOTO 1102
%       NOTE: SAVE FIELD NAME AND CHECK FOR DUPLICATE NAME
%1103 WRITE #SØ1
%       NOTE: #SØ1 IS FIELD NAME FOR WHICH SCAN IS TO BE MADE
%       NOTE: #LRCST IS RECORD POINTER TO START OF FIELD RECORDS
%       NOTE: #LFLDS IS CURRENT FIELD NO.
%       NOTE: #LFLD IS NO. OF FIELD TO BE SCANNED
%       NOTE: INITIALISE FIELD COUNTER
%       #LFLD=1
%       #LREC=#LRCST
%       IF #LFLDS.LE.1,GOTO 1106
%       NOTE: READ FIELD NAME RECORD
%1104 FREAD #LREC,#SØ2
%       IF #SØ1.AT.#SØ2,GOTO 1105
%       #LREC=#LREC+2
%       #LFLD=#LFLD+1
%       IF #LFLD.LT.#LFLDS,GOTO 1104
%       NOTE: REQUEST SECURITY LEVEL FOR CURRENT FIELD
%1106 DEPOSITØ WHICH%SECURITY%LEVEL%DO%YOU%WISH%TO%ASSIGN%TO%#SØ1?\
%       WRITE
%       DEPOSITØ PLEASE%TYPE%A%NUMBER%IN%THE%RANGE%1%TO%#GSLVL.%\
%       CALLCOPY(44,1=HIGHEST%LEVEL)
%       WRITE
%       DEPOSITØ #GSLVL%=%LØWEST%LEVEL\
%       WRITE
```

```
%       NOTE: READ AND VALIDATE SECURITY LEVEL
%1107 CALL 9000
%       WRITE #S03
%       IF ',',.IN.#S03,GOTO 1100
%       IF #S03.IN.#S08,GOTO 1108
%       NOTE: INVALID SECURITY LEVEL
%1100 DEPOSIT0 #S03%IS%AN%INVALID%SECURITY%LEVEL\
%       WRITE
%       GOTO 1107
%       NOTE: DUPLICATE NAME
%1105 DEPOSIT0 DUPLICATE%NAME\
%       WRITE
%       GOTO 1102
%       NOTE: SAVE SECURITY LEVEL
%1108 DEPOSIT1 ,#S03,\
%       NOTE: REQUEST FIELD START POSITION
%       DEPOSIT0 IN%WHICH%CHARACTER%POSITION%DOES%THE%FIELD%START?\
%       WRITE
%       DEPOSIT0 1%IS%THE%FIRST%CHARACTER%POSITION%IN%THE%RECORD\
%       WRITE
%       NOTE: READ AND VALIDATE START POSITION
%1111 CALL 9000
%       SQUASH
%       #GINP=1
%1109 CALLFSTR(#LV1,0,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.0,GOTO 1110
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 1109
%       #GOUP=#GSTC
%       CALLFSTR(#LV1,1,0)
%       #GOUP=1
%       CALLCONV(#LV1,#LV1)
%       IF #LV1.LT.1,GOTO 1110
%       IF #LV1.GT.#GRSZ,GOTO 1110
%       NOTE: SAVE START POSITION
%       DEPOSIT1 #LV1,\
%       NOTE: REQUEST FIELD LENGTH
%       DEPOSIT0 HOW%MANY%CHARACTER%POSITIONS%DOES%THE%FIELD%OCCUPY?\
%       WRITE
%       NOTE: READ AND VALIDATE FIELD SIZE
%1114 CALL 9000
%       SQUASH
%       #GOUP=#GSTC
%       #GINP=1
%1113 CALLFSTR(#LV2,0,1)
%       TESTDIGT(#LV2)
```

```
%       IF #GTST.NE.0,GOTO 1112
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 1113
%       CALLFSTR(#LV2,1,0)
%       #GOUP=1
%       CALLCONV(#LV2,#LV2)
%       IF #LV2.LT.1,GOTO 1112
%       IF #LV2.GT.120,GOTO 1112
%       #LV3=#LV1+#LV2-1
%       IF #LV3.GT.#GRSZ,GOTO 1112
%       NOTE: SAVE FIELD LENGTH
%       DEPOSIT1 #LV2,\
%       NOTE: READ AND VALIDATE FIELD TYPE
%       DEPOSITØ DOES%THIS%FIELD%CONTAIN%NUMERIC%OR%ALPHANUMERIC%DATA?\
%       WRITE
%       DEPOSITØ PLEASE%TYPE%N%FOR%NUMERIC%OR%A%FOR%ALPHANUMERIC\
%       WRITE
%1115   SQUASH
%       IF #GSTC.NE.1,GOTO 1116
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'AN',GOTO 1200
%       NOTE: INVALID FIELD TYPE
%1116   DEPOSITØ #LV1%INVALID,%ONLY%A%OR%N%VALID\
%       WRITE
%       GOTO 1115
%       NOTE: INVALID START POSITION
%1110   DEPOSITØ START%POSITION%MUST%BE%GREATER%THAN%Ø%AND%LESS%THAN\
%       WRITE
%       DEPOSITØ OR%EQUAL%TO%#GRSZ\
%       WRITE
%       GOTO 1111
%       NOTE: INVALID FIELD LENGTH
%1112   DEPOSITØ FIELD%LENGTH%MUST%BE%GREATER%THAN%Ø,%LESS%THAN%121\
%       WRITE
%       DEPOSITØ AND%SUCH%THAT%FIELD%DOES%NOT%OVERFLOW%THE%END%OF%RECORD\

%       WRITE
%       GOTO 1114
%       NOTE: TEST FIELD TYPE
%1200   IF #LV1.EQ.'A',GOTO 1201
%       NOTE: REQUEST DECIMAL POINT LOCATION OF NUMERIC FIELD
%       DEPOSITØ PLEASE%TYPE%THE%POSITION%OF%THE%DECIMAL%POINT\
%       WRITE
%       DEPOSITØ RELATIVE%TO%THE%RIGHTHAND%CHARACTER%OF%THE%FIELD\
%       WRITE
%       DEPOSITØ TYPE%L%FOR%LEFT%OR%R%FOR%RIGHT%FOLLOWED%BY%AN%UNSIGNED%\
```

```
%       CALLCOPY(56,INTEGER)
%       WRITE
%1202   CALL 9000
%       SQUASH
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'LR',GOTO 1204
%       NOTE: INVALID DECIMAL POINT LOCATION
%1203   DEPOSIT0 INVALID%DECIMAL%POINT%LOCATION\
%       WRITE
%       GOTO 1202
%1204   #GINP=2
%1205   CALLFSTR(#LV1,0,1)
%       TESTDIGT(#LV1)
%       IF #GTST.NE.0,GOTO 1203
%       #GINP=#GINP+1
%       IF #GINP.LE.#GSTC,GOTO 1205
%       #GOUP=#GSTC-1
%       CALLFSTR(#LV1,2,0)
%       CALLCONV(#LV1,#LV1)
%       IF #LV1.GT.99,GOTO 1203
%       #GOUP=#GSTC
%       CALLFSTR(#LV1,1,0)
%       #GOUP=1
%       NOTE: STORE POINT LOCATION
%       DEPOSIT1 N,#LV1,\
%       GOTO 1206
%       NOTE: STORE FIELD TYPE FOR ALPHANUMERIC TYPE
%1201   DEPOSIT1 A,,\
%       NOTE: REQUEST KEY FIELD INDICATOR
%1206   DEPOSIT0 PLEASE%TYPE%FIELD%KEY%NO.%IN%THE%RANGE%0%TO%9\
%       WRITE
%       DEPOSIT0 0%DENOTES%A%NON-KEY%FIELD,%1%DENOTES%THE%MAJOR%KEY\
%       WRITE
%1209   CALL 9000
%       WRITE #S02
%       SQUASH
%       IF #GSTC.GT.1,GOTO 1208
%       IF #S02.IN.#S07,GOTO 1207
%1208   DEPOSIT0 INVALID%KEY%INDICATOR%OR%FIELD%NOT%OF%LOWEST%SECURI\
%       CALLCOPY(52,TY%LEVEL)
%       WRITE
%       GOTO 1209
%1207   IF #S02.IN.#S06,GOTO 1208
%       IF #S02.EQ.'0',GOTO 1221
%       DEPOSIT6 #S02,\
%1221   DEPOSIT1 #S02,\
%       IF #S02.EQ.'0',GOTO 1210
```

```
%       NOTE: REQUEST AND ENTER SEQUENCE CODE
%       DEPOSIT0 PLEASE%INDICATE%SEQUENCE%ORDER.%TYPE%A%FOR%ASCENDING%OR\

%       WRITE
%       DEPOSIT0 D%FOR%DESCENDING\
%       WRITE
%1212 CALL 9000
%       SQUASH
%       IF #GSTC.NE.1,GOTO 1211
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'AD',GOTO 1213
%       NOTE: INVALID SEQUENCE INDICATOR
%1211 DEPOSIT0 INVALID%SEQUENCE%INDICATOR\
%       WRITE
%       GOTO 1212
%       NOTE: SAVE SEQUENCE INDICATOR
%1213 DEPOSIT1 #LV1,\
%       NOTE: TEST FOR NON-MAJOR KEY
%       IF #S02.EQ.'1',GOTO 1214
%       NOTE: DOES NON-MAJOR KEY FORM A DOMAIN
%1230 DEPOSIT0 CAN%FIELD%BE%TREATED%AS%A%DOMAIN?.%TYPE%Y%FOR%YES%OR%N%\

%       CALLCOPY(56,FOR%NO)
%       WRITE
%1216 CALL 9000
%       SQUASH
%       IF #GSTC.NE.1,GOTO 1215
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'YN',GOTO 1217
%       NOTE: INVALID DOMAIN INDICATION
%1215 DEPOSIT0 INVALID%DOMAIN%INDICATION\
%       WRITE
%       GOTO 1216
%       NOTE: DUMMY SEQUENCE
%1210 DEPOSIT1 ,\
%       GOTO 1230
%       NOTE: DUMMY DOMAIN INDICATOR
%1214 DEPOSIT1 ,\
%       GOTO 1218
%       NOTE: SAVE DOMAIN INDICATOR
%1217 DEPOSIT1 #LV1,\
%       NOTE: WRITE FIELD DESCRIPTION RECORD TYPE 1
%1218 INSERT #GREC,#S01
%       NOTE: UPDATE RECORD POINTER
%       #GREC=#GREC+1
%       NOTE: REQUEST FIELD DESCRIPTION
%       DEPOSIT0 PLEASE%TYPE%UP%TO%70%CHARACTERS%OF%DESCRIPTION%ABOUT%THE\
```

```
%       CALLCOPY(57,%FIELD)
%       WRITE
%       CALL 9000
%       WRITE #S01
%       INSERT #GREC,#S01
%       #GREC=#GREC+1
%       NOTE: UPDATE CURRENT FIELD NO.
%       #LFLDS=#LFLDS+1
%       NOTE: DECREASE FIELD COUNT
%       #GFLDS=#GFLDS-1
%       IF #GFLDS.GT.0,GOTO 1101
(5)     NOTE: CHECK THAT ALL KEYS HAVE BEEN ALLOCATED
%       #LV1=1
%1219   RESET #S01
%       DEPOSIT1 #LV1\
%       IF #S01.IN.#S06,GOTO 1220
%       NOTE: NOT ALL KEYS ALLOCATED
%       DEPOSIT0 NOT%ALL%KEYS%HAVE%BEEN%ALLOCATED.REQUEST%TERMINATED\
%       WRITE
%       NOTE: DELETE DESCRIPTION
%       #LV1=#GSLVL/5
%       #LV2=#LFLDS-1*2
%       #LREC=#LV1+#LV2+3
%       #GREC=#GREC-#LREC
%1231   DELETE #GREC
%       #LREC=#LREC-1
%       IF #LREC.GT.0,GOTO 1231
%       GOTO 100
%1220   #LV1=#LV1+1
%       IF #LV1.LE.#GNKEY,GOTO 1219
(6)     NOTE: UPDATE CATALOGUE FILE COUNT AND RECORD COUNT
%       #GFCT=#GFCT+1
%       #LV1=#GSLVL/5
%       #LV2=#LFLDS-1*2
%       #GRCT=#GRCT+#LV1+#LV2+3
%       DATE
%       TIME
%       RESET #S01
%       DEPOSIT1 #GFCT,#GRCT,#GCATP,#GSLVL,#GCDT,#GCTM,\
%       REPLACE 1,#S01
(7)     DEPOSIT0 CATALOGUE%UPDATED%ON%#GCDT%AT%#GCTM\
%       WRITE
%       GOTO 100
%       NOTE: VALIDATE NAME STRING STARTING IN 1ST POSITION OF INPUT BUFF

%       NOTE: #GNERR = ERROR INDICATOR
```

```
%       NOTE: CLEAR ERROR INDICATOR
%200    #GNERR=0
%       NOTE: TEMPORARILY SAVE CONTENTS OF INPUT BUFFER
%       WRITE
%       NOTE: CHECK NO. OF CHARACTERS KEYED
%       SQUASH
%       IF #GSTC.GT.#GLENG,GOTO 202
%       NOTE: CHECK FOR IMBEDDED BLANKS
%209    WRITE #S02
%       IF #S01.NE.#S02,GOTO 203
%       NOTE: CHECK FIRST CHARACTER FOR HYPHEN OR Z
%210    CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'Z-',GOTO 204
%       NOTE: CHECK LAST CHARACTER FOR HYPHEN
%211    #GINP=#GSTC
%       CALLFSTR(#LV1,0,1)
%       IF #LV1.EQ.'-',GOTO 205
%       NOTE: SET UP LOOP TO CHECK FOR ALPHABETIC, NUMERIC AND HYPHEN ONLY

%212    #GINP=1
%       NOTE: ZEROISE COUNT OF ALPHA CHARACTERS
%       #LALPH=0
%       NOTE: EXTRACT NEXT CHARACTER
%213    CALLFSTR(#LV1,0,1)
%       NOTE: TESTDIGT(#LV1)
%       IF #GTST.EQ.0,GOTO 206
%       NOTE: TEST ALPHABETIC
%       TESTLETR(#LV1)
%       IF #GTST.EQ.0,GOTO 207
%       NOTE: TEST FOR HYPHEN
%       IF #LV1.EQ.'-',GOTO 206
%       NOTE: INVALID CHARACTER FOUND
%       DEPOSIT0 #LV1%INVALID%CHARACTER,%ONLY%A%TO%Z,%0%TO%9%AND%-%ALLOWE

%       CALLCOPY(54,D)
%       WRITE
%       NOTE: SET ERROR INDICATOR ON
%       #GNERR=1
%       NOTE: UPDATE POINTER AND TEST FOR END OF LOOP
%206    #GINP=#GINP+1
%       IF #GINP.GT.#GSTC,GOTO 214
%       GOTO 213
%       NOTE: TEST FOR AT LEAST ONE ALPHA CHARACTER
%214    IF #LALPH.GT.0,GOTO 208
%       NOTE: NO ALPHA CHARACTER CHARACTER PRESENT
%       DEPOSIT0 AT%LEAST%ONE%ALPHABETIC%CHARACTER%MUST%BE%INCLUDED\
%       WRITE
```

```
%       #GNERR=1
%208    EXIT
%       NOTE: MORE THAN PERMITTED CHARACTERS IN NAME
%202    DEPOSIT0 MORE%THAN%#GLENG%CHARACTERS%IN%NAME\
%       WRITE
%       #GNERR=1
%       GOTO 209
%       NOTE: BLANKS NOT ALLOWED
%203    DEPOSIT0 BLANKS%NOT%ALLOWED\
%       WRITE
%       #GNERR=1
%       GOTO 210
%       NOTE: FIRST CHARACTER HYPHEN OR Z
%204    DEPOSIT0 Z%OR%HYPHEN%NOT%ALLOWED%AS%FIRST%CHARACTER\
%       WRITE
%       #GNERR=1
%       GOTO 211
%       NOTE: LAST CHARACTER HYPHEN
%205    DEPOSIT0 HYPHEN%NOT%ALLOWED%AS%LAST%CHARACTER\
%       WRITE
%       #GNERR=1
%       GOTO 212
%       NOTE: ADD 1 TO ALPHABETIC COUNT
%207    #LALPH=#LALPH+1
%       GOTO 206
%       NOTE: ISSUE PROMPT AND READ REPLY
%9000   DEPOSIT0 :\
%       WRITE
%       READ
%       EXIT
%999    CONTINUE
%END
```

17. DIAL1 AND STAGE1 SUBFILES

```
STAGE 1 - INTRODUCTION
THIS SYSTEM IS A SELF-TEACHING COBOL PROGRAM GENERATOR.
BY MEANS OF A QUESTION AND ANSWER DIALOGUE THE SYSTEM WILL ENABLE YOU TO

SPECIFY BOTH YOUR PROBLEM AND THE DATA TO BE USED. THE SYSTEM WILL THEN

GENERATE A COBOL PROGRAM TO PROVIDE YOU WITH YOUR ANSWERS.
IF AT ANY TIME DURING THE DIALOGUE YOU WISH TO CHANGE YOUR MIND ABOUT AN

EARLIER DECISION OR REQUIRE ASSISTANCE PLEASE TYPE %HELP. SHOULD YOU
WISH TO ABANDON THE SESSION PLEASE TYPE CTRL A INSTEAD.
IN MANY INSTANCES THE SYSTEM OFFERS YOU A DEFAULT RESPONSE TO A
QUESTION. TO TAKE ADVANTAGE OF THIS OPTION YOU MERELY PRESS THE ACCEPT
KEY ON YOUR TERMINAL KEYBOARD.
THE SYSTEM TAKES A RELATIONAL VIEW OF THE DATABASE.
THE DATABASE IS A COLLECTION OF STORED DATA AVAILABLE FOR USE IN THE
SOLUTION OF A PROBLEM.
THE DATABASE IS MADE UP OF DOMAINS, EACH OF WHICH CONTAINS A SET OF DATA

ITEMS RELATING TO A PARTICULAR ATTRIBUTE.
E.G. AN EMPLOYEE-NAME DOMAIN CONTAINS THE SET OF ALL EMPLOYEE NAMES AND

     A DEPARTMENT-NO DOMAIN CONTAINS THE SET OF ALL DEPARTMENT NUMBERS.

     A DIFFERENT NUMBER OF ITEMS MAY BE PRESENT IN EACH DOMAIN SET.
A RELATION MAY BE DEFINED ON SEVERAL DOMAINS SUCH THAT FOR EVERY ITEM
IN ONE DOMAIN OF THE RELATION THERE EXISTS ONE AND ONLY ONE
CORRESPONDING ITEM IN EACH OF THE OTHER DOMAINS IN THE RELATION.
E.G. A PERSONNEL RELATION MAY BE DEFINED ON THE DOMAINS EMPLOYEE-NAME,
     ADDRESS AND DEPARTMENT-NO. THUS EACH EMPLOYEE BELONGS TO ONLY ONE
     DEPARTMENT AND LIVES AT ONE ADDRESS, ALTHOUGH SEVERAL EMPLOYEES
     MAY BELONG TO THE SAME DEPARTMENT OR LIVE AT THE SAME ADDRESS.
THE EASIEST WAY TO VISUALISE THE DATA IN A RELATION IS IN TABULAR FORM,

WHERE THE DOMAIN NAMES PROVIDE THE COLUMN HEADINGS AND THE ITEMS FROM
EACH DOMAIN SET PROVIDE THE ROW ENTRIES.
THUS THE DATA IN THE PERSONNEL RELATION MENTIONED ABOVE COULD BE
CONSIDERED AS A TABLE OF WHICH THE FOLLOWING IS AN EXTRACT:-
PERSONNEL RELATION
------------------
EMPLOYEE-NAME       !   ADDRESS                          ! DEPARTMENT-NO

--------------------!------------------------------------!--------------

BROWN  A.B.         !24 HIGH STREET, SOUTHTON            !      14
BROWN  L.M.         !24 HIGH STREET, SOUTHTON            !      02
BLACK  C.D.E.       !31 MILL LANE, WESTHAM               !      14
JONES  T.           !4  CHURCH ROAD, EASTLEY             !      02
RILEY  S.M.         !THE CREST, HILL RISE, NORTHAM       !      06
SCOTT  P.J.         !7 CASTLE STREET, SOUTHTON           !      09
THE GENERATED COBOL PROGRAM WILL RETRIEVE YOUR DATA IN SUCH A WAY THAT
YOU MAY CONSIDER THE DATA IN THE RELATION TABLE TO BE AVAILABLE ON A
ROW BY ROW BASIS, ONE ROW AT A TIME.
```

```
%DEF  STAGE1@@
%     NOTE: INTRODUCTION - CHECK POINT 1
%     NOTE: SET CHECK POINT NO.
%     #GCKPT=1
%     NOTE: PRINT INTRODUCTORY DIALOGUE FOR STAGE 1
%     SELECT DIAL1
%     #LLINE=1
%1    FREAD #LLINE,#S@1
%     DEPOSIT@ #S@1\
%     WRITE
%     IF #LLINE.LE.44,GOTO 1
%     NOTE: CHAIN TO STAGE2
      [CHAIN@,STAGE2]
      [STAGE2@1@]
%END
```

18. DIAL2 AND STAGE2 SUBFILES

STAGE 2 - PASSWORD DIALOGUE
ACCESS TO THE SYSTEM DATABASE IS BY MEANS OF A RELATION NAME AND ITS ASSOCIATED PASSWORD. THE RELATION NAMES AND PASSWORDS ARE ALLOCATED BY THE DATABASE ADMINISTRATOR TO WHOM AN APPLICATION TO USE THE SYSTEM SHOULD BE MADE. DATA FROM MORE THAN ONE RELATION MAY BE REQUESTED TO SOLVE YOUR PROBLEM.

```
%DEF   STAGE2@@
%      NOTE: PASSWORD DIALOGUE - CHECK POINT 2
%      NOTE: SET CHECK POINT NO.
%      #GCKPT=2
%      NOTE: PRINT INTRODUCTORY DIALOGUE FOR STAGE 2
%      SELECT DIAL2
%      #LLINE=1
%1     FREAD #LLINE,#SØ1
%      DEPOSITØ #SØ1\
%      WRITE
%      #LLINE=#LLINE+1
%      IF #LLINE.LE.6,GOTO 1
%      NOTE: ZEROISE RELATION COUNT AND RECORD POINTER
%      #GNREL=Ø
%      #LREC=Ø
%      NOTE: SELECT RELATION DICTIONARY
%      SELECT RELATIONDICT
%      #LITEM='FIRST'
%      NOTE: REQUEST RELATION NAME
%6     DEPOSITØ PLEASE%TYPE%THE%NAME%OF%THE%#LITEM%RELATION%WHOSE%DATA\
%      WRITE
%      DEPOSITØ YOU%WISH%TO%ACCESS\
%      WRITE
```

```
%       NOTE: READ AND SAVE RELATION NAME
%       CALL 9000
%       WRITE #S01
%       NOTE: REQUEST PASSWORD
%       DEPOSIT0 PLEASE%TYPE%THE%PASSWORD%FOR%RELATION%#S01\
%       WRITE
%       NOTE: READ AND SAVE PASSWORD
%       CALL 9000
%       CALLFSTR(#LPASS,1,8)
%       IF #GNREL.NE.0,GOTO 8
%       NOTE: INCREMENT RELATION COUNT AND RECORD POINTER
%7      #LREC=#LREC+1
%9      #GNREL=#GNREL+1
%       NOTE: ENTER RELATION NAME AND PASSWORD IN RELATION DICTIONARY
%       DEPOSIT0 ,#LPASS,\
%       INSERT #LREC,#S01
%       IF #GNREL.EQ.9,GOTO 3
%4      DEPOSIT0 HAVE%YOU%ANY%MORE%RELATIONS%TO%ENTER?%PLEASE%TYPE%\
%       CALLCOPY(51,Y%FOR%YES%OR%N)
%       WRITE
%       DEPOSIT0 FOR%NO.%THE%DEFAULT%REPLY%IS%NO.\
%       WRITE
%       CALL 9000
%       CALLFSTR(#LV1,1,1)
%       SQUASH
%       IF #GSTC.GT.1,GOTO 12
%       IF #LV1.EQ.'Y',GOTO 2
%       IF #LV1.IN.' N',GOTO 3
%       NOTE: INVALID RESPONSE
%12    DEPOSIT0 INVALID%RESPONSE\
%       WRITE
%       GOTO 4
%       NOTE: MORE RELATIONS TO COME
%2     #LITE4='NEXT'
%       GOTO 6
%       NOTE: NO MORE RELATIONS TO ENTER CHAIN TO NEXT STAGE
%3     CONTINUE
       [CHAIN0,STAGE3]
       [STAGE3@1@]
%       GOTO 9999
%       NOTE: ISSUE PROMPT, READ RESPONSE AND DETECT PLEA FOR HELP
%9000  DEPOSIT0 :\
%       WRITE
%       READ
%       CALLFSTR(#LV1,1,5)
```

```
%       IF #LV1.EQ.'%HELP',GOTO 9001
%       EXIT
%9001   CONTINUE
        [CHAIN0,HELP]
        [HELP@1@]
%       GOTO 9999
%       NOTE: CHECK FOR DUPLICATE RELATION NAME
%       NOTE: INITIALISE RECORD POINTER
%8      #LREC=1
%       NOTE: READ AND EXTRACT RELATION NAME
%10     FREAD #LREC,#S02
%       VSTR3 #S02,1,,
%       NOTE: COMPARE RELATION NAMES
%       IF #S01.EQ.#S03,GOTO 11
%       IF #S01.LT.#S03,GOTO 9
%       NOTE: TEST FOR ANY MORE RELATIONS TO SCAN
%       IF #GNREL.EQ.#LREC,GOTO 7
%       NOTE: UPDATE RECORD POINTER
%       #LREC=#LREC+1
%       GOTO 10
%       NOTE: DUPLICATE RELATION NAME
%11     DEPOSIT0 DUPLICATE%RELATION%NAME.%NAME%IGNORED\
%       WRITE
%       GOTO 4
%9999   CONTINUE
%END
```

19. DIAL3 AND STAGE3 SUBFILES

STAGE 3 - USERS DATABASE SUBMODEL
THE DOMAINS IN EACH RELATION OF YOUR DATABASE WILL BE SHOWN BELOW TOGETHER WITH DETAILS OF THE SIZE AND TYPE OF THE ITEMS THEY CONTAIN THE SIZE INDICATES THE NUMBER OF CHARACTERS IN EACH ITEM OF THE DOMAIN AND THE TYPE SHOWS IF THEY ARE NUMERIC(N) OR ALPHANUMERIC(A). THE DECIMAL POINT OF A NUMERIC ITEM IS ASSUMED TO BE AFTER THE RIGHT-MOST CHARACTER UNLESS OTHERWISE INDICATED. THE POINT LOCATION SHOWS THE DIRECTION, LEFT(L) OR RIGHT(R), TOGETHER WITH A CHARACTER COUNT RELATIVE TO THE RIGHT-MOST CHARACTER.

E.G.

ITEM SIZE	POINT LOCATION	ITEM CONTENTS	NUMERIC VALUE OF CONTENTS
5	L2	17463	174.63
3	R3	468	468000.

WHERE DATA FROM A RELATION IS READILY AVAILABLE IN AN ORDERED SEQUENCE,

THE KEY DOMAINS WHICH DETERMINE THAT SEQUENCE WILL ALSO BE LISTED IN ORDER, STARTING WITH THE MAJOR KEY (KEY NO. 1) AND FINISHING WITH THE MINOR KEY.

```
%DEF   STAGE3@@
%      NOTE: DATABASE SUBMODEL - CHECK POINT 3
(1)    %      NOTE: SET CHECK POINT NO.
%      #GCKPT=3
(2)    %      NOTE: PRINT INTRODUCTORY DIALOGUE
%      #LLINE=1
%      SELECT DIAL3
%1     FREAD #LLINE,#S01
%      DEPOSIT0 #S01\
%      WRITE
%      #LLINE=#LLINE+1
%      IF #LLINE.LE.16,GOT 1
(3)    %      NOTE: SELECT CATALOGUE, READ CONTROL RECORD, EXTRACT FIELDS
%      NOTE: AND CONVERT NUMERIC FIELDS TO BINARY
%      SELECT CATALOGUE
```

```
%       READ #S01
%       NOTE: CATALOGUE FILE COUNT
%       CALLVSTR(#LCFCT,1,,)
%       #GINP=#GCCT+2
%       NOTE: CATALOGUE RECORD COUNT
%       CALLVSTR(#LCRCT,0,,)
%       #GINP=#GINP+#GCCT+1
%       NOTE: CATALOGUE PASSWORD
%       CALLVSTR(#LCPW,0,,)
%       #GINP=#GINP+#GCCT+1
%       NOTE: NO. OF SECURITY LEVELS
%       CALLVSTR(#LSLVL,0,,)
%       CALLCONV(#LCFCT,#LCFCT)
%       CALLCONV(#LCRCT,#LCRCT)
%       CALLCONV(#LSLVL,#LSLVL)
(4)
%       NOTE: INITIALISE SUBMODEL SUBFILE COUNTERS - FILE AND RECORD
%       #LSFCT=0
%       #LSRCT=1
%       NOTE: ZEROISE DOMAIN COUNT
%       #LDCT=0
%       NOTE: INITIALISE RELATION DICTIONARY POINTER
%       #LRPT=1
%       NOTE: INITIALISE CATALOGUE POINTER
%       #LCPT=2
%       NOTE: CLEAR ERROR INDICATOR
%       #LERR=0
(5)
%       NOTE: SELECT RELATION DICTIONARY
%       NOTE: READ RELATION RECORD, EXTRACT RELATION NAME AND PASSWORD
%2      CALL 50
%       NOTE: READ FILENAME RECORD TYPE 1 INTO #S01
%3      FREAD #LCPT,#S01
%       NOTE: EXTRACT FIELDS
%       NOTE: FILENAME INTO #S03
%       VSTR3 #S01,1,,
%       NOTE: EXTRACT FIELD COUNT AND CONVERT TO BINARY
%       READ #S01
%       #GINP=#GCCT+2
%       CALLVSTR(#LCFDC,0,,)
%       CALLCONV(#LCFDC,#LCFDC)
%       NOTE: SAVE POINTER TO START OF PASSWORDS
%       #LINP=#GINP+#GCCT+1
%       NOTE: TEST FOR MORE THAN 4 SECURITY LEVELS
%       IF #LSLVL.LE.4,GOTO 4
%       NOTE: READ REMAINING PASSWORDS INTO #S04
%       #LCPT=#LCPT+1
```

```
%       NOTE: COMPARE RELATION NAME WITH CATALOGUE FILENAME
%4      IF #S02.GT.#S03,GOTO 6
%       IF #S02.LT.#S03,GOTO 7
%       NOTE: MATCH FOUND - PRINT RELATION NAME AND DOMAIN HEADINGS
%       DEPOSITØ RELATION%NAME%%%#S02\
%       WRITE
%       DEPOSITØ DETAILS%OF%DOMAINS%WITHIN%THE%RELATION\
%       WRITE
%       DEPOSITØ DOMAIN%NAME%%%%%%ITEM%SIZE%%TYPE%%POINT%LOCATION\
%       WRITE
%       NOTE: DETERMINE PASSWORD SECURITY LEVEL
%       #LV1=1
%       #GINP=#LINP
%8      CALLFSTR(#LPASS,Ø,8)
%       #GINP=#GINP+9
%       IF #LPASS.EQ.#LRPW,GOTO 10Ø
%       #LV1=#LV1+1
%       IF #LV1.GT.#LSLVL,GOTO 11
%       IF #LV1.LE.4,GOTO 8
%       NOTE: LOAD REMAINING PASSWORDS
%       READ #SØ4
%       #GINP=1
%12     CALLFSTR(#LPASS,Ø,8)
%       #GINP=#GINP+9
%       IF #LPASS.EQ.#LRPW,GOTO 10Ø
%       #LV1=#LV1+1
%       IF #LV1.LE.#LSLVL,GOTO 12
%       NOTE: SET ERROR INDICATOR AND PRINT MESSAGE
%11     #LERR=1
%       DEPOSITØ INVALID%PASSWORD%NO%DOMAINS%ACCESSIBLE\
%       WRITE
%       NOTE: UPDATE CATALOGUE POINTER
%       #LCPT=#LCPT+3+#LCFDC+#LCFDC
%       GOTO 42
%       NOTE: UPDATE RELATION POINTER
%13     #LRPT=#LRPT+1
%       NOTE: TEST FOR MORE RELATIONS
%       IF #LRPT.GT.#GNREL,GOTO 14
%       NOTE: SELECT RELATION DICTIONARY AND PROCESS NEXT RELATION RECORD

%       CALL 5Ø
%       GOTO 4
%       NOTE: UPDATE CATALOGUE POINTER
%6      #LCPT=#LCPT+3+#LCFDC+#LCFDC
%       IF #LSLVL.LE.4,GOT 16
```

```
%       #LCPT=#LCPT+1
%       NOTE: TEST FOR END OF CATALOGUE
%16     IF #LCPT.LT.#LCRCT,GOTO 3
%       NOTE: RELATION NOT IN CATALOGUE
%       #LERR=1
%       DEPOSITØ RELATION%#SØ2%NOT%IN%DATABASE\
%       WRITE
%       GOTO 14
%7      #LERR=1
%       DEPOSITØ RELATION%#SØ2%NOT%IN%DATABASE\
%       WRITE
%       GOTO 13
%       NOTE: TEST ERROR INDICATOR
%14     IF #LERR.EQ.Ø,GOTO 17
%       DEPOSITØ USER%ERRORS%PREVENT%FURTHER%PROGRESS.%DO%YOU%WISH%TO%\
%       CALLCOPY(54,RESPECIFY%YOUR)
%       WRITE
%       DEPOSITØ RELATIONS?%PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO.THE%DEFAULT\

%       CALLCOPY(57,%REPLY%IS%NO.)
%       WRITE
%18     CALL 9ØØØ
%       SQUASH
%       IF #GSTC.GT.1,GOTO 19
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'Y',GOTO 2Ø
%       IF #LV1.IN.'N ',GOTO 21
%19     DEPOSITØ INVALID%RESPONSE\
%       WRITE
%       GOTO 18
%       NOTE: WRITE SUBMODEL CONTROL RECORD
%17     SELECT SUBMODEL
%       RESET #SØ1
%       DEPOSIT1 #LSFCT,#LSRCT,\
%       REPLACE 1,#SØ1
%       NOTE: WRITE DOMAINDICT CONTROL RECORD
%       SELECT DOMAINDICT
%       REPLACE 1,#LDCT
        [CHAINØ,STAGE3-1]
        [STAGE3-1@1@]
%       GOTO 9999
%2Ø     CONTINUE
        [CHAINØ,STAGE2]
        [STAGE2@1@]
%       GOTO 9999
%21     CONTINUE
```

```
%       WRITE
%       GOTO 9999
%       NOTE: ROUTINE TO READ USERS RESPONSE AND DETECT A PLEA FOR HELP
%       NOTE: ISSUE PROMPT
%9000  DEPOSIT0 :\
%       WRITE
%       READ
%       CALLFSTR(#LV1,1,5)
%       IF #LV1.EQ.'%HELP',GOTO 9001
%       EXIT
%9001  CONTINUE
        [CHAIN0,HELP]
        [HELP@1@]
%       GOTO 9999
(7) %       NOTE: EXTRACT FILE RECORD TYPE 3 FROM CATALOGUE
%10     #LCPT=#LCPT+2
%       FREAD #LCPT,#S03
%       NOTE: INITIALISE KEY DICTIONARY COUNT
%       #GNKEY=0
%       NOTE: INITIALISE SUBMODEL FIELD COUNT
%       #LSFDC=0
%       NOTE: SELECT SUBMODEL AND INSERT TYPE 1 AND TYPE 3 RECORDS
%       SELECT SUBMODEL
(  ) %       #LSRCT=#LSRCT+1
%       INSERT #LSRCT,#S02
%       NOTE: SAVE RECORD POINTER
%       #LSPT=#LSRCT
%       #LSRCT=#LSRCT+1
%       INSERT #LSRCT,#S03
%       NOTE: ADD 1 TO SUBMODEL FILE COUNT
%       #LSFCT=#LSFCT+1
(8) %       NOTE: SELECT CATALOGUE AND READ TYPE 1 RECORD
%31     SELECT CATALOGUE
%       #LCPT=#LCPT+1
%       FREAD #LCPT,#S01
%       NOTE: REDUCE CATALOGUE FIELD COUNT BY 1
%       #LCFDC=#LCFDC-1
%       NOTE: EXTRACT NAME AND SECURIIITY LEVEL - NAME IN #S02
%       VSTR2 #S01,1,,
%       READ #S01
%       #GINP=#GCCT+2
(  ) %       CALLFSTR(#LV2,0,1)
%       CALLCONV(#LV2,#LV2)
%       NOTE: TEST IF USER HAS ACCESS TO FIELD
```

(9)

```
%       NOTE: USER HAS ACCESS, EXTRACT REMAINING FIELDS
%       #GINP=#GINP+2
%       CALLVSTR(#LV3,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV4,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV5,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV6,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV7,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV8,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV9,0,,)
%       NOTE: SELECT DOMAIN DICTIONARY AND BINARY SEARCH FOR NAME
%       SELECT DOMAINDICT
%44     #LLOW=2
%       #LHIGH=#LDCT+1
%27     IF #LLOW.GT.#LHIGH,GOTO 24
%       #LCUR=#LLOW+#LHIGH
%       #LCUR=#LCUR/2
%       FREAD #LCUR,#S04
%       NOTE: EXTRACT DOMAIN NAME IN #S03
%       VSTR3 #S04,1,,
%       IF #S03.GT.#S02,GOTO 25
%       IF #S03.EQ.#S02,GOTO 26
%       #LLOW=#LCUR+1
%       GOTO 27
%       #LHIGH=#LCUR-1
%       GOTO 27
%       NOTE: MATCHING NAME FOUND - TEST FOR KEY DOMAIN
%26     IF #LV7.NE.'0',GOTO 23
%       NOTE: DOMAIN NAME IN MORE THAN ONE RELATION - RESOLVE AMBIGUITY BY

%       NOTE: APPENDING  RELATION COUNT TO FILL OUT NAME
%43     DEPOSIT2 #LRPT\
%       CALL LENV #S02
%       IF #GSTC.LT.15,GOTO 43
%       GOTO 44
%       NOTE: MATCHING NAME NOT FOUND - TEST FOR KEY DOMAIN
%24     IF #LV7.EQ.'0',GOTO 28
%       NOTE: ENTER DOMAIN NAME IN KEY DICTIONARY
%       SELECT KEYDICT
```

```
%       REPLACE #LV7,#SØ2
%       NOTE: ADD 1 TO KEY COUNT
%       #GNKEY=#GNKEY+1
%28     SELECT DOMAINDICT
%       NOTE: ENTER NAME IN DOMAIN DICTIONARY
%       #LDCT=#LDCT+1
%       RESET #SØ3
%       DEPOSIT3 #SØ2,#LV4,#LV5,#LV6,#LV7,#LV8,#LV9,\
%       INSERT #LLOW,#SØ3
(10)    NOTE: SELECT SUBMODEL AND ENTER FIELD DESCRIPTION
%23     SELECT SUBMODEL
%       RESET #SØ1
%       DEPOSIT1 #SØ2,#LV3,#LV4,#LV5,#LV6,#LV7,#LV8,#LV9,\
%       #LSRCT=#LSRCT+1
%       INSERT #LSRCT,#SØ1
%       NOTE: INCREMENT SUBMODEL FIELD COUNT
%       #LSFDC=#LSFDC+1
%       NOTE: PRINT FIELD DETAILS
%       #GOUP=1
%       DEPOSITØ #SØ2\
%       #GOUP=21
%       DEPOSITØ #LV4\
%       #GOUP=3Ø
(  )    DEPOSITØ #LV5\
%       IF #LV6.EQ.'LØ',GOTO 34
%       IF #LV6.EQ.'RØ',GOTO 34
%       #GOUP=38
%       DEPOSITØ #LV6\
%34     WRITE
%       NOTE: UPDATE CATALOGUE RECORD POINTER
%33     #LCPT=#LCPT+1
%       NOTE: TEST FOR MORE FIELDS
%       IF #LCFDC.GT.Ø,GOTO 31
%       NOTE: UPDATE CATALOGUE POINTER
%       #LCPT=#LCPT+1
(11)    NOTE: UPDATE SUBMODEL FILE RECORD TYPE 1
%       FREAD #LSPT,#SØ1
$       DEPOSIT1 ,#LSFDC,\
%       REPLACE #LSPT,#SØ1
(12)    NOTE: PRINT KEY HEADING
%       DEPOSITØ KEY%NO.%%KEY%DOMAIN%NAME\
%       WRITE
(  )    SELECT KEYDICT
```

```
%        #LKPT=1
%41      FREAD #LKPT,#S01
%        #GOUP=3
%        DEPOSIT0 #LKPT\
%        #GOUP=10
%        DEPOSIT0 #S01\
%        WRITE
%        #LKPT=#LKPT+1
%        IF #LKPT.LE.#GNKEY,GOTO 41
%        NOTE: UPDATE RELATION POINTER AND TEST FOR MORE RELATIONS
%42      #LRPT=#LRPT+1
%        IF #LRPT.GT.#GNREL,GOTO 14
%        NOTE: READ AND EXTRACT DETAILS OF NEXT RELATION
%        CALL 50
%        GOTO 16
%        NOTE: READ RELATION RECORD, EXTRACT NAME AND PASSWORD
%50      SELECT RELATIONDICT
%        FREAD #LRPT,#S01
%        VSTR2 #S01,1,,
%        READ #S01
%        #GINP=#GCCT+2
%        CALLVSTR(#LRPW,0,,)
%        SELECT CATALOGUE
%        EXIT
%9999    CONTINUE
%END
```

20. STAGE3-1 SUBFILE

```
%DEF   STAGE3-1@@
%      NOTE: CHECK FOR DISJOINTED OR DISCONNECTED RELATIONS
%      NOTE: TEST FOR MORE THAN ONE RELATION
%      IF #GNREL.EQ.1,GOTO 23
(1)    NOTE: SELECT SUBMODEL, READ AND EXTRACT FILE AND RECORD COUNTS
%      SELECT SUBMODEL
%      FREAD 1,#S01
%      READ #S01
%      CALLVSTR(#LSFCT,1,,)
%      #GINP=#GCCT+2
%      CALLVSTR(#LSRCT,0,,)
%      NOTE: CONVERT COUNTS TO BINARY
%      CALLCONV(#LSFCT,#LSFCT)
%      CALLCONV(#LSRCT,#LSRCT)
(2)    NOTE: INITIALISE SUBMODEL RECORD POINTER
%      #LSPT=2
%      NOTE: ZEROISE KEYCOUNT
%      #GNKEY=0
(3)    NOTE: READ FILE DESCRIPTION RECORDS
%1     CALL 8
%      NOTE: TEST KEY COUNT
%      IF #LKYCT.GT.#GNKEY,GOTO 2
%      NOTE: UPDATE RECORD POINTER
%      #LSPT=#LSPT+#LFDCT+1
%      NOTE: TEST FOR END OF SUBMODEL
%3     IF #LSPT.LE.#LSRCT,GOTO 1
%      GOTO 7
%      NOTE: UPDATE KEY COUNT
%2     #GNKEY=#LKYCT
%      NOTE: SAVE FILE POINTER
%      #LSAVE=#LSPT-1
%      NOTE: SET SUBMODEL RECORD POINTER
%      #LSPT=#LSPT+1
%      NOTE: READ FIELD RECORD
%4     CALL 9
%      NOTE: TEST FOR KEY FIELD
%      IF #LKEY.NE.'0',GOTO 5
%      NOTE: REDUCE FIELD COUNT
%6     #LFDCT=#LFDCT-1
%      NOTE: UPDATE RECORD POINTER
```

```
%       #LSPT=#LSPT+1
%       NOTE: TEST FOR END OF FIELD RECORDS
%       IF #LFDCT.NE.0,GOTO 4
%       GOTO 3
%       NOTE: SELECT KEY DICTIONARY AND ENTER KEY NAME
%5      CALLCONV(#LKEY,#LKEY)
%       SELECT KEYDICT
%       REPLACE #LKEY,#S01
%       NOTE: SELECT SUBMODEL
%       SELECT SUBMODEL
%       GOTO 6
%       NOTE: RESET SUBMODEL RECORD POINTER
%7      #LSPT=1
%       NOTE: READ FILE DESCRIPTION RECORDS
%11     #LSPT=#LSPT+1
%       NOTE: TEST FOR SAVED FILE
%       IF #LSAVE.EQ.#LSPT,GOTO 24
%       NOTE: READ FILE RECORDS
%       CALL 8
%       NOTE: READ FIELD RECORD
%10     #LSPT=#LSPT+1
%       CALL 9
%       NOTE: TEST FOR KEY FIELD
%       IF #LKEY.NE.'0',GOTO 12
%       NOTE: REDUCE FIELD COUNT
%       #LFDCT=#LFDCT-1
%       IF #LFDCT.EQ.0,GOTO 13
%       GOTO 10
%       NOTE: CONVERT KEY NO. TO BINARY AND SAVE
%12     CALLCONV(#LKEY,#LKEY)
%       #LSKY=#LKEY
%       NOTE: BINARY SEARCH KEY DICTIONARY FOR MATCHING NAME
%       #LLOW=1
%       #LHIGH=#GNKEY
%       SELECT KEYDICT
%16     IF #LLOW.GT.#LHIGH,GOTO 13
%       #LCUR=#LHIGH+#LLOW
%       #LCUR=#LCUR/2
%       FREAD #LCUR,#S02
%       IF #S02.EQ.#S01,GOTO 14
%       IF #S02.LT.#S01,GOTO 15
%       #LHIGH=#LCUR-1
%       GOTO 16
%15     #LLOW=#LCUR+1
%       GOTO 16
%       NOTE: REDUCE FIELD COUNT
%14     #LFDCT=#LFDCT-1
```

```
%       NOTE: UPDATE RECORD POINTER
%       #LSPT=#LSPT+1
%       NOTE: TEST FOR MORE FILE DESCRIPTIONS
%25     IF #LSPT.LE.#LSRCT,GOTO 11
%       NOTE: CHAIN TO NEXT STAGE
%23     CONTINUE
        [CHAINØ,STAGE4]
        [STAGE4@1@]
%       GOTO 9999
%       NOTE: UPDATE SUBFILE POINTER
%24     #LSPT=#LSPT+#LFDCT+2
%       GOTO 25
%       NOTE: ERROR DETECTED
%13     DEPOSITØ YOUR%CHOSEN%RELATIONS%CANNOT%BE%JOINED%TOGETHER.%DO%YOU\

%       CALLCOPY(56,%WISH%TO)
%       WRITE
%       DEPOSITØ RESPECIFY%YOUR%RELATION%NAMES?%PLEASE%TYPE%Y%FOR%YES%OR%\

%       CALLCOPY(57,N%FOR%NO.%THE)
%       WRITE
%       DEPOSITØ DEFAULT%REPLY%IS%NO.\
%       WRITE
%22     CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 19
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'Y',GOTO 20
%       IF #LV1.IN.'N ',GOTO 21
%19     DEPOSITØ INVALID%RESPONSES\
%       WRITE
%       GOTO 22
%20     CONTINUE
        [CHAINØ,STAGE2]
        [STAGE2@1@]
%       GOTO 9999
%21     DEPOSITØ RUN%ABANDONED.\
%       WRITE
%       GOTO 9999
%       NOTE: ROUTINE TO READ USERS RESPONSE AND DETECT A PLEA FOR HELP
%9000   READ
%       CALLFSTR(#LV1,1,5)
%       IF #LV1.EQ.%HELP',GOTO 9001
%       EXIT
%9001   CONTINUE
        [CHAINØ,HELP]
```

```
        [HELP#1#]
%       GOTO 9999
%       NOTE: SELECT SUBMODEL AND UPDATE RECORD POINTER
%17     SELECT SUBMODEL
%       #LSPT=#LSPT+1
%       CALL 9
%       IF #LKEY.EQ.'0',GOTO 14
%       NOTE: CONVERT KEY NO. TO BINARY
%       CALLCONV(#LKEY,#LKEY)
%       NOTE: CALCULATE KEY LOCATION IN DICTIONARY
%       NOTE: CHECK FOR VALID POINTER
%       #LKPT=#LLOW-#LSKY+#LKEY
%       IF #LKPT.LE.0,GOTO 13
%       IF #LKPT.GT.#GNKEY,GOTO 13
%       NOTE: SELECT KEY DICTIONARY AND CHECK KEY NAME
%       SELECT KEYDICT
%       FREAD #LKPT,#S02
%       IF #S01.NE.#S02,GOTO 13
%       GOTO 14
%       NOTE: READ FILE DESCRIPTION RECORDS TYPE 1 AND TYPE 3
%8      FREAD #LSPT,#S01
%       NOTE: EXTRACT FIELD COUNT
%       VSTR2 #S01,1,,
%       READ #S01
%       #GINP=#GCCT+2
%       CALLVSTR(#LFDCT,0,,)
%       NOTE: READ TYPE 2 RECORD
%       #LSPT=#LSPT+1
%       FREAD #LSPT,#S01
%       NOTE: EXTRACT KEY COUNT
%       READ #S01
%       CALLVSTR(#LV1,1,,)
%       #GINP=#GCCT+2
%       CALLVSTR(#LV2,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV3,0,,)
%       #GINP=#GINP+#GCCT+14
%       CALLVSTR(#LV4,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV5,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV6,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LKYCT,0,,)
%       NOTE: CONVERT KEY COUNT TO BINARY
%       CALLCONV(#LKYCT,#LKYCT)
%       EXIT
```

```
%       NOTE: READ FIELD DESCRIPTION RECORD
%9      FREAD #LSPT,#S02
%       NOTE: EXTRACT FIELD NAME AND KEY NO.
%       VSTR1 #S02,1,,
%       READ #S02
%       #GINP=#GCCT+2
%       CALLVSTR(#LV1,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV2,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV3,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV4,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV5,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LKEY,0,,)
%       EXIT
%9999   CONTINUE
%END
```

21. DIAL4 AND STAGE4 SUBFILES

STAGE 4 -SELECTION OF RELEVANT DOMAINS
YOUR DATABASE CONTAINS A NUMBER OF DOMAINS NOT ALL OF WHICH MAY BE REQUIRED TO SOLVE YOUR CURRENT PROBLEM. THE SYSTEM IS ABOUT TO LIST THE

CONTENTS OF YOUR DATABASE DOMAIN BY DOMAIN; AFTER EACH DOMAIN NAME YOU WILL BE ASKED WHETHER OR NOT THE CURRENT DOMAIN FEATURES IN YOUR PROBLEM.
SHOULD YOU SO DESIRE, THE SYSTEM WILL AUTOMATICALLY ACCUMULATE A TOTAL FOR THE ITEMS RETRIEVED FROM ANY NUMERIC DOMAIN. YOU WILL BE ASKED TO INDICATE IF YOU WISH TO AVAIL YOURSELF OF THIS FEATURE.

```
%DEF    STAGE4@@
%       NOTE: CHECK POINT 4 - SELECTION OF PROBLEM DOMAINS
%       NOTE: SET CHECK POINT NO.
%       #GCKPT=4
%       NOTE: PRINT OUT INTRODUCTORY DIALOGUE FOR STAGE 4
%       SELECT DIAL4
%       #LLINE=1
%1      FREAD #LLINE,#S@1
%       DEPOSIT@ #S@1\
%       WRITE
%       #LLINE=#LLINE+1
%       IF #LLINE.LE.9,GOTO 1
%       NOTE: SET DOMAINLIST AND DOMAINDICT RECORD POINTERS
```

```
%       #LDDCT=1

%       NOTE: CLEAR TOTALS INDICATOR
%       #GTOT=0
%       NOTE: SELECT DOMAIN DICTIONARY, READ AND EXTRACT DOMAIN COUNT
%       SELECT DOMAINDICT
%       FREAD #LDDPT,#LDCT
%       CALLCONV(#LDCT,#LDCT)
%       NOTE: UPDATE DOMAINDICT POINTER, READ DOMAIN RECORD
%2      #LDDPT=#LDDPT+1
%       FREAD #LDDPT,#S01
%       NOTE: EXTRACT FIELDS
%       VSTR2 #S01,1,,
%       READ #S01
%       #GINP=#GCCT+2
%       CALLVSTR(#LV4,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV5,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV6,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV7,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV8,0,,)
%       #GINP=#GINP+#GCCT+1
%       CALLVSTR(#LV9,0,,)
%       NOTE: PRINT DOMAIN NAME
%       DEPOSIT0 #S02\
%       WRITE
%       DEPOSIT0 DOES%THE%ABOVE%DOMAIN%FEATURE%IN%YOUR%PROBLEM?%PLEASE%TY\

%       CALLCOPY(57,PE%Y%FOR%YES%OR)
%       WRITE
%       DEPOSIT0 N%FOR%NO.%THE%DEFAULT%REPLY%IS%NO.\
%       WRITE
%3      CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 4
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.EQ.'Y',GOTO 5
%       IF #LV1.IN.'N ',GOTO 16
%4      OBEY 2100,3
%       NOTE: BY DEFAULT INCLUDE KEY DOMAINS
%16     IF #LV7.EQ.'0',GOTO 6
%       GOTO 7
%       NOTE: DOMAIN TO BE USED. TEST DOMAIN TYPE.
```

```
%5      IF #LV5.EQ.'A',GOTO 7
(8) %   NOTE: NUMERIC DOMAIN. ASK USER IF TOTALS REQUIRED
%       DEPOSIT# DO%YOU%WISH%THE%SYSTEM%TO%ACCUMULATE%A%TOTAL%OF%RETRIEVE\

%       CALLCOPY(57,D%ITEMS%IN%THIS)
%       WRITE
%       DEPOSIT# DOMAIN?%PLEASE%TYPE%Y%FOR%YES%OR%N%FOR%NO.%THE%DEFAULT%R\

%       CALLCOPY(57,EPLY%IS%NO.)
%       WRITE
%8      CALL 9000
%       SQUASH
%       IF #GSTC.GT.1,GOTO 9
%       CALLFSTR(#LV1,1,1)
%       IF #LV1.IN.'N ',GOTO 7
%       IF #LV1.EQ.'Y',GOTO 10
%       OBEY 2100,8
(9) %   NOTE: SET TOTALS INDICATOR
%10    #GTOT=1
(10) %  NOTE: SET TOTALS MARKER
%       #LV2='T'
%       GOTO 15
%       NOTE: CLEAR TOTALS MARKER
%7      #LV2=' '
%       NOTE: SELECT DOMAIN LIST AND ENTER RECORD IN SUBFILE
%15    SELECT DOMAINLIST
%       #LDLPT=#LDLPT+1
%       RESET #S01
%       DEPOSIT1 #S02,#LV2,#LV4,#LV5,#LV6,#LV7,#LV8,#LV9,\
%       INSERT #LDLPT,#S01
%       SELECT DOMAINDICT
%       NOTE: REDUCE DOMAIN COUNT
%6      #LDCT=#LDCT-1
%       IF #LDCT.NE.4,GOTO 2
(11) %  NOTE: UPDATE DOMAINLIST CONTROL RECORD
%       #LDLPT=#LDLPT-1
%       SELECT DOMAINLIST
%       REPLACE 1,#LDLPT
(12) %  NOTE: CHAIN TO NEXT STAGE
        [CHAIN0,STAGE5]
        [STAGE5@1@]
%       GOTO 9999
%       NOTE: PRINT INVALID RESPONSE MESSAGE
%2100  DEPOSIT# INVALID%RESPONSE.\
%       WRITE
%       RETURN
%       NOTE: ROUTINE TO READ USERS RESPONSE AND DETECT A PLEA FOR HELP
%9000  DEPOSIT0 :\
%       WRITE
%       READ
%       CALLFSTR(#LV1,1,5)
%       IF #LV1.EQ.'%HELP',GOTO 9001
%       EXIT
%9001  CONTINUE
        [CHAIN0,HELP]
        [HELP@1@]
%9999  CONTINUE
%END
```

28. DIALHELP AND HELP SUBFILES

THE FOLLOWING OPTIONS ARE AVAILABLE TO YOU IN RESPONSE TO YOUR PLEA FOR HELP:-

1. ABANDON THE RUN.
2. RESTART THE DIALOGUE AT THE BEGINNING OF THE CURRENT STAGE OR AT A PREVIOUS STAGE.
3. TO SEE THE DIALOGUE FOR THE CORRESPONDING STAGE OF THE SAMPLE PROBLEM AND RESUME PROCESSING AT THE BEGINNING OF THE CURRENT STAGE.
4. TO EXPERIMENT WITH EDITING DATA AND THEN TO RESUME PROCESSING AT THE BEGINNING OF THE CURRENT STAGE.

18 OWN CODE PROCESSING
17 VIEW OF SAMPLE REPORT PAGE
16 TOTAL LINE(S) SPECIFICATION
15 SUB-TOTAL LINE(S) SPECIFICATION
14 SEQUENCE BREAK HEADING SPECIFICATION
13 PAGE HEADING SPECIFICATION
12 REPORT TITLE SPECIFICATION
11 EXTRA DATA ITEMS - DATE, TIME, PAGE NO.
10 DETAIL LINE(S) SPECIFICATION
9 EDITING
8 REPORT LAYOUT INTRODUCTION
7 SELECTION OF DATA FOR RETRIEVAL
6 DATABASE INCONSISTENCIES
5 TEMPORARY EXTENSION OF DATABASE
4 SELECTION OF RELEVANT DOMAINS
3 DATABASE SUBMODEL
2 PASSWORD DIALOGUE
1 INTRODUCTION

AT WHICH OF THE ABOVE STAGE NOS. DO YOU WISH TO RESTART?

~~%DEF HELP00~~
~~% NOTE: HELP MACRO~~
~~% NOTE: EMPTY OUTPUT STACK OF ANY LEFT OVER RUBBISH~~

```
%DEF   HELP@@
%      NOTE: HELP MACRO
(1) %  NOTE: EMPTY OUTPUT STACK OF ANY LEFT OVER RUBBISH
%      SAVE,0,WORK
%      NOTE: PRINT INTRODUCTORY DIALOGUE
%9001  SELECT DIALHELP
(2) %  NOTE: TEST CHECK POINT VALUE TO DETERMINE HOW MANY OF THE OPTIONS

%      NOTE: SHOULD BE OFFERED TO THE USER
%      IF #GCKPT.LT.9,GOTO 1
%      #LRANJ='123'
%      #LLAST=8
%      GOTO 2
%1     #LRANJ='1234'
%      #LLAST=10
%2     #LLINE=1
(3) %  CALL 2000
(4) %  NOTE: REQUEST USER TO SPECIFY SELECTED OPTION
%      DEPOSIT0 PLEASE%TYPE%THE%NUMBER%OF%YOUR%SELECTED%OPTION.%THE%DEF\

%      CALLCOPY(56,AULT%REPLY%IS%1.)
%      WRITE
(5) %  NOTE: READ AND VALIDATE USERS RESPONSE
%3     CALL 9000
%      SQUASH
%      IF #GSTC.GT.1,GOTO 4
%      CALLFSTR(#LV1,1,1)
%      IF #LV1.EQ.' ',GOTO 10
%      IF #LV1.IN.#LRANJ,GOTO 5
%      NOTE: INVALID OPTION NO.
```

```
%4      DEPOSIT@ INVALID%OPTION%NO.\
%       WRITE
%       GOTO 3
%       NOTE: SET DEFAULT RESPONSE
%10     #LV1=1
%       GOTO 11
(6) %   NOTE: BRANCH TO PROCESSING FOR SELECTED OPTION
%5      CALLCONV(#LV1,#LV1)
   %11  #LV1=#LV1+5
%       GOTO #LV1
(7) %   NOTE: OPTION 1 - ABANDON RUN
%6      DEPOSIT@ RUN%ABANDONED.%PLEASE%TYPE%@1@FINISH\
%       WRITE
%       EXIT
(8) %   NOTE: OPTION 2 - RESTART AT AN EARLIER CHECK POINT
%       NOTE: COMPUTE LINE NO. FOR START OF STAGE LIST
%7      #LLINE=29-#GCKPT
%       #LLAST=29
(9) %   NOTE: PRINT LIST OF AVAILABLE RESTART STAGES AND REQUEST
%       NOTE: RESTART STAGE NO.
%       CALL 2000
(10) %  NOTE: READ AND VALIDATE STAGE NO.
%43     CALL 9000
%       SQUASH
%       IF #GSTC.LT.1,GOTO 41
%       IF #GSTC.GT.2,GOTO 41
%       IF #GSTC.EQ.1,GOTO 42
   %    CALLFSTR(#LV1,2,1)
%       TESTDIGT(#LV1)
%       IF #GTST.EQ.0,GOTO 41
%42     CALLFSTR(#LV1,1,1)
%       TESTDIGT(#LV1)
%       IF #GTST.EQ.0,GOTO 41
%       #GOUP=#GSTC
%       CALLVSTR(#LV1,1,0)
%       #GOUP=1
%       CALLCONV(#LV1,#LV1)
%       IF #LV1.GT.#GCKPT,GOTO 41
%       IF #LV1.LT.1,GOTO 41
(11) %  NOTE: ADJUST CHECK POINT VARIABLE
%44     #GCKPT=#LV1-1
(12) %  NOTE: CHAIN TO REQUESTED STAGE
%       IF #GCKPT.GT.5,GOTO 34
%45     CONTINUE
        [CHAIN4,STAGE#LV1]
```

```
        [STAGE#LV1=1]
%       GOTO 9999
%       NOTE: INVALID RESTART NO.
%41     DEPOSIT0 INVALID%RESTART%STAGE%NO.\
%       WRITE
%       GOTO 43
%       NOTE: CHANGE MAINFILE
%30     IF #GCKPT.LE.13,GOTO 31
%       IF #GCKPT.EQ.14,GOTO 32
%       IF #GCKPT.EQ.15,GOTO 33
%       MAINFILE,GWAC132-DAT4
%       GOTO 45
%31     MAINFILE,GWAC132-DAT1
%       GOTO 45
%32     MAINFILE,GWAC132-DAT2
%       GOTO 45
%33     MAINFILE,GWAC132-DAT3
%       GOTO 45
%       NOTE: OPTION 3 - PRINT SAMPLE DIALOGUE FOR CURRENT STAGE
%       NOTE: ESTABLISH RANGE OF LINES TO BE PRINTED
%8      #LV1=1000+#GCKPT
%       GOTO #LV1
%1001   #LLAST=45
%       GOTO 1100
%1002   #LLAST=30
%       GOTO 1100
%1003   #LLAST=46
%       GOTO 1100
%1004   #LLAST=72
%       GOTO 1100
%1005   #LLAST=188
%       GOTO 1100
%1006   #LLAST=17
%       GOTO 1100
%1007   #LLAST=45
%       GOTO 1100
%1008   #LLAST=91
%       GOTO 1100
%1009   #LLAST=69
%       GOTO 1100
%1010   #LLAST=29
%       GOTO 1100
%1011   #LLAST=13
%       GOTO 1100
%1012   #LLAST=36
%       GOTO 1100
```

```
%       GOTO 1100
%1014 #LLAST=40
%       GOTO 1100
%1015 #LLAST=38
%       GOTO 1100
%1016 #LLAST=24
%       GOTO 1100
%1017 #LLAST=101
%       GOTO 1100
%1018 #LLAST=221
%1100 #LLINE=1
%       MAINFILE,GWAC132-MODL
%       SELECT MODEL#GCKPT
%       IF #GCKPT.EQ.17,GOTO 3000
%       CALL 2000
%1101 MAINFILE,GWAC132-DATA
%       #LV1=#GCKPT
%       GOTO 44
%       NOTE: OUTPUT MODEL17 SUBFILE
%3000 FREAD #LLINE,#S01
%       NOTE: REPLACE > BY BLANK
%       IF '<'.AT.#S01,GOTO 3001
%3002 DEPOSIT0 #S01\
%       WRITE
%       #LLINE=#LLINE+1
%       IF #LLINE.LE.#LLAST,GOTO 3000
%       GOTO 1101
%3001 SWAP1,>,
%       GOTO 3002
%       NOTE: OPTION 4 - TRIAL EDITING
%9      MAINFILE,GWAC132-DAT1
       [CHAIN0,STAGE9]
       [STAGE9@1@]
%       GOTO 9999
%       NOTE: ROUTINE TO ISSUE PROMPT, READ RESPONSE AND DETECT HELP PLE

%9000 DEPOSIT0 :\
%       WRITE
%       READ
%       CALLFSTR(#LV1,1,5)
%       IF #LV1.EQ.'%HELP',GOTO 9001
%       EXIT
%       NOTE: PRINT REQUIRED LINES FROM SELECTED FILE
%2000 FREAD #LLINE,#S01
%       DEPOSIT0 #S01\
%       WRITE
%       #LLINE=#LLINE+1
%       IF #LLINE.LE.#LLAST,GOTO 2000
%       EXIT
%9999 CONTINUE
%END
```